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Bulletin OF THE INTERNATIONAL Oceanographic FOUNDATION

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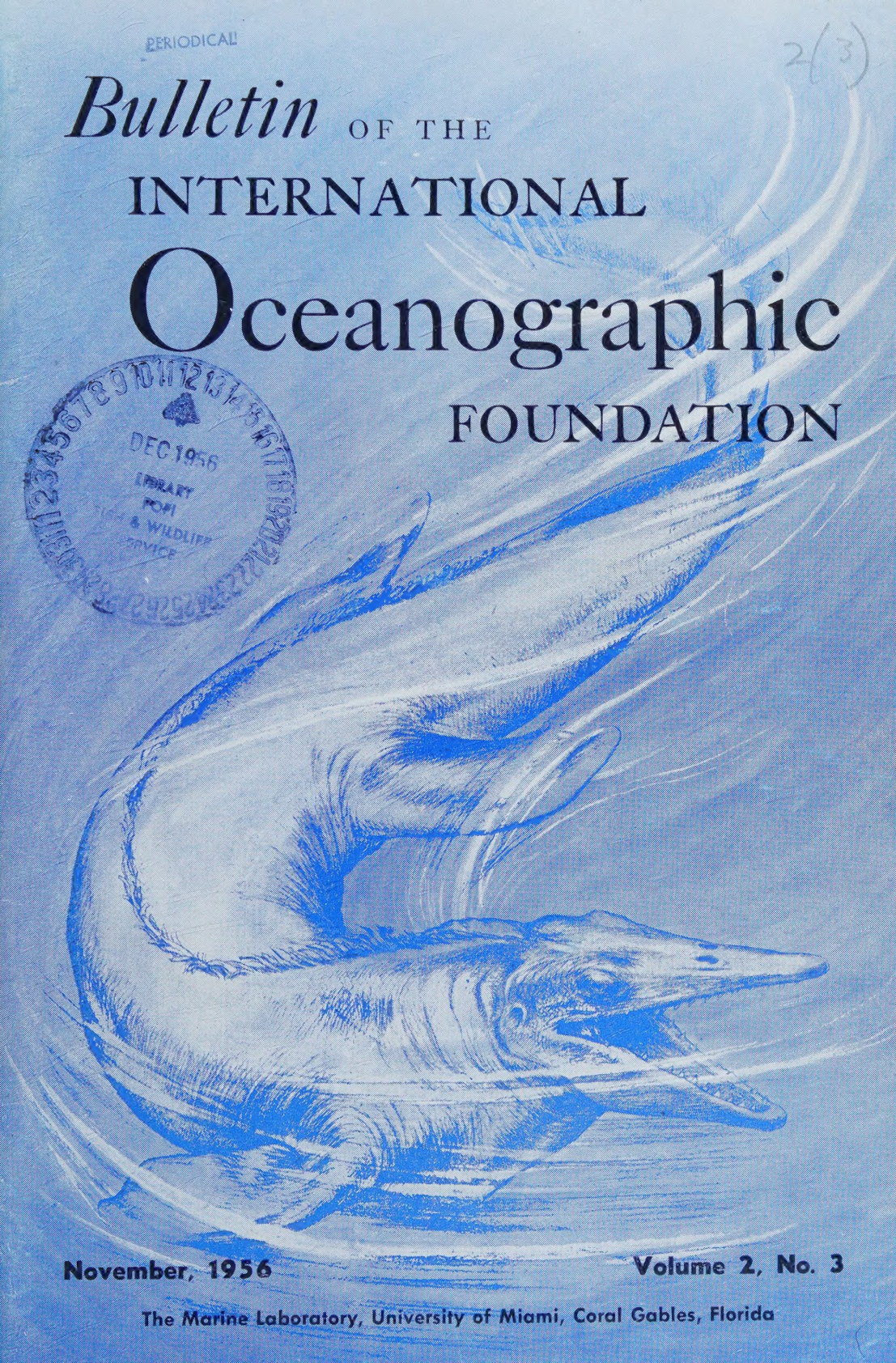

November, 1956 Volume 2, No. 3

The Marine Laboratory, University of Miami, Coral Gables, Florida

TO ALL APPEARANCES *the men in this photograph are walking on water, without any means of support. In actual fact it was common enough sight to those taking part in the University of Miami—Lou Marron expedition to the west coast of South America. The men are handline fishermen who put out from Cabo Blanco on open sailing or motor boats to a distance of as much as fifteen miles offshore. Balsa rafts towed behind the vessels are there set adrift at intervals of about one mile apart with two fishermen on each. At the end of the day they are again picked up. A few, however, are lost each year, which is not surprising.*

FRONT COVER. For story on this extinct seagoing reptile, see article in this issue on *Monsters of the Ancient Seas.*

BULLETIN of the
INTERNATIONAL
OCEANOGRAPHIC
FOUNDATION

Editorial Office: The Marine Laboratory, University of Miami, Coral Gables, Fla.

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A Report to Members

By F. G. WALTON SMITH

MEMBERS of The International Oceanographic Foundation are united in a simple and easily stated interest—scientific discovery and the exploration of the ocean. This has a special fascination not only for those interested in ships and the sea and in marine discovery, but for all who have a vestige of adventurous spirit, since the ocean is the last unexplored frontier of the world. Man has found his way to the ends of the earth and into the thin air far above the land, through a series of adventurous and sometimes hazardous explorations, and through the imagination of those who planned them and the high courage and devotion of those who carried them out. Now, with most of the land well mapped, we turn to the ocean, where man has never set foot on the deeper bottom and where he has still to send his instruments down to measure and sample huge stretches of untouched seafloor.

New Frontier of Resources

Our knowledge of the complex actions and interactions of currents and winds, of heat and cold, of salt and fresh, of chemical changes and of the biological processes of marine plants and animals, is still in its infancy. Not only is the pursuit of knowledge and discovery an adventure and an aim fitting to the highest dignity of civilized man, it is also upon such enquiries as well as upon the expeditions to sea which they entail, that later generations will base their increased utilization of sea food resources and minerals and will learn to predict and perhaps control hurricanes and weather. Biochemists will break through the frontier to bring new drugs and lifegiving products from the life in the sea. Though the land is our natural place and the sea an alien element, yet it will be conquered for our use.

A New Magazine

In these times, when the scientific discoveries of today are often the basis of the technology and industry of tomorrow, it is more than ever important to make information about them available to all who are interested. Members of the Foundation have supported this idea by making possible the Bulletin, which attempts to provide articles written for the general reader, so as to bring to him the entire field of ocean science and discovery. The Bulletin, in this, is attempting to fill a need that has long been voiced but never satisfied. Members, as they increase in number, will also make it possible for continued improvement so that informative accounts of the latest and most exciting discoveries of the oceans may be presented in a well edited and illustrated magazine in the most attractive and interesting form. In addition to articles, it is hoped that special features such as reviews of new books will regularly appear.

Many members are inspired solely by a love of the sea. Others are yachtsmen, anglers, fishermen and mariners whose interest in the ocean is for pleasure or business, and who wish both to keep informed and to foster scientific research and exploration. Many are themselves marine scientists who, because of the increasing degree of scientific specialization, see in the Bulletin a potential for keeping up-to-date on advances in fields different from their own and in countries far removed. Their support as members and also through willingly assisting in the exchange of information by writing articles has been a major help in the task of starting the magazine.

Conference for Anglers

Arising from the suggestions and requests of members, the Foundation, although still in its infancy, has undertaken other activities. One way of fostering the development of ocean science and discovery and the exchange of ideas between the scientist and the general public is by means of conferences. A meeting has therefore been arranged between anglers, charter boat skippers and marine biologists who are studying the salt water game fishes and will take place in Nassau, Bahamas, in November of this year. A notice of this will be found elsewhere in this issue.

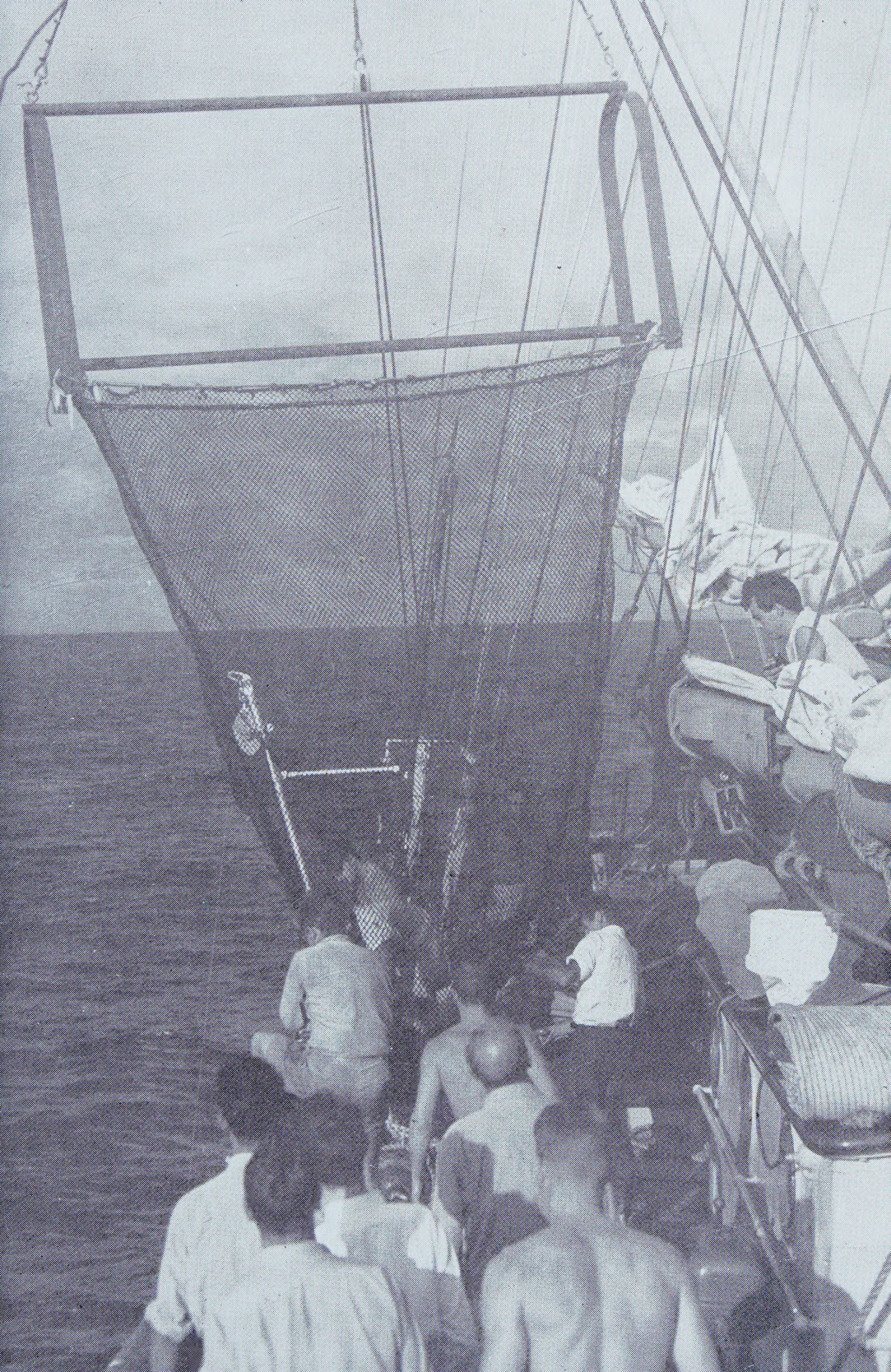
Among the ideas put forward to advance the informational and educational objectives of the Foundation have been those of establishing modern museums in suitable localities where the facts and ideas of modern marine science may be demonstrated in an attractive and stimulating fashion. Committees have already been set up to study this and other services. Moving pictures, in 16 mm color, have been proposed and one is already available for distribution to clubs, libraries and educational institutions on request.

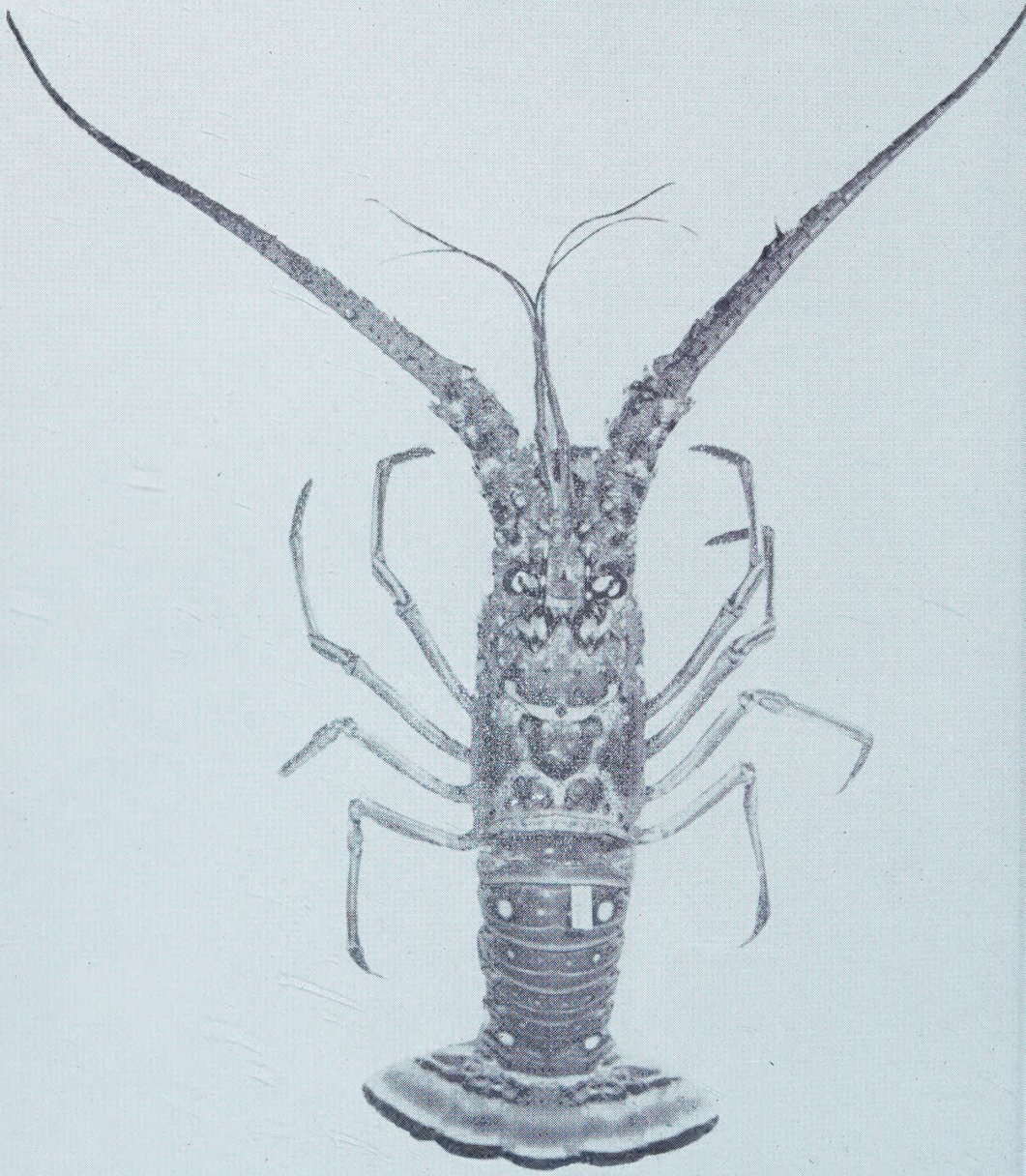
Bulletin Reaches 10,000

In these ways the common interest is being pursued. In the short period of its life, the Bulletin has now reached a circulation of 10,000, not all of whom are members. They are drawn from the United States, Canada, Central and South America, Great Britain, Australia, France, Germany, Italy, Denmark, Sweden and Norway, as well as a few from the Pacific Islands and the West Indies. The continued improvement will follow the growth of active membership. It will be seen in better service, with more articles in the Bulletin of high interest and authenticity.

Members are joined in these aims and they are urged to make progress possible by taking the small effort needed to enlist new members. To those who are not members, but whose interest and curiosity lie in the sea and in the spirit of discovery, there is extended an invitation to participate by simply mailing a card. The ocean is our last frontier and its exploration still under way.

TRAWLS USED *for exploring the sea floor may bring up strange creatures never before known, even from great depths.*





CRAWFISH TAG, *applied between plates of the tail. As used at Miami.*

Fingerprinting Fish

By ALFRED V. VOLPE

The Marine Laboratory, University of Miami

THE CAPTURE of a tagged fish is a rare experience to the average angler. His curiosity is immediately aroused by the cryptic message attached to the body or fin of his catch. "How far did this fish travel?" is his first thought. He can obtain this information by mailing the tag, with information as to date and place of capture, to the address given on the tag. The fishery biologist will obtain much more information from the tag, for tagging offers one of the best means of obtaining accurate data on speed and direction of migration, growth of the fish and on the intensity of fishing effort expended by anglers and commercial fishermen. The tagging of fish is, in fact, one of the most useful tools in the hands of the biologist.

Who Was the First to Tag?

Marking or tagging fish is an old practice. Isaac Walton in "The Compleat Angler," written in 1653, mentions having heard that before his time fish were marked by tying ribbons around their tails. This early fish marking was probably done more in a spirit of amusement than scientific research. In the spring of 1852 an Englishman, Alexander Russel, mentions that 500 young salmon along the coast of England were marked by means of plain silver. Only three of these marked fish were ever recovered. One of these three was found in the stomach of a codfish, with nothing remaining of him but his vertebrate column and the silver wire.

Different Kinds of Tags

The credit for the first systematic fish tagging belongs to Charles G. Atkins who tagged Atlantic salmon in 1872 at Bucksport, Maine.

At first Atkins attempted to mark salmon by branding the side of the fish and by cutting the fins into a variety of forms. He found that the best marking method was the use of metallic tags attached to the body of the fish. The first tag tried consisted of a thin aluminum plate stamped with a recorded number and was attached to a rubber band which encircled the tail of the salmon. No success was attained with this type of tag for the rubber bands rolled away or slipped off. The next type of mark was an aluminum tag attached to the rear margin of the first dorsal or back fin by means of a platinum wire. The aluminum tag did not stand up well in sea water and was later replaced by a plate, about half an inch long and quarter of an inch wide, made of platinum. Atkins was the first investigator to offer a reward for the return of these salmon tags. No doubt the cost of the platinum tag influenced his decision to discontinue these unquestionably durable tags. Possibly also there was some temptation for the

finder to keep for himself an apparently valuable discovery.

Further Tagging Experiments

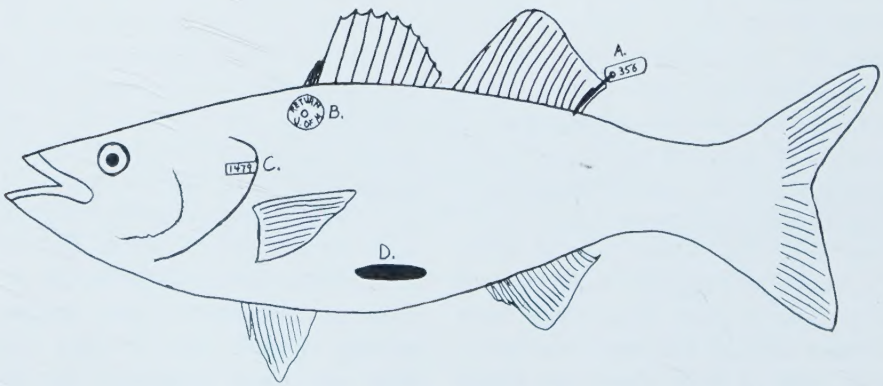
W. E. Archer, a Scottish biologist, developed another type of tag in 1884, consisting of a platinum or silver tag which was closely attached at the base of the dorsal fin with the ends of wire tightly pressed along the fin.

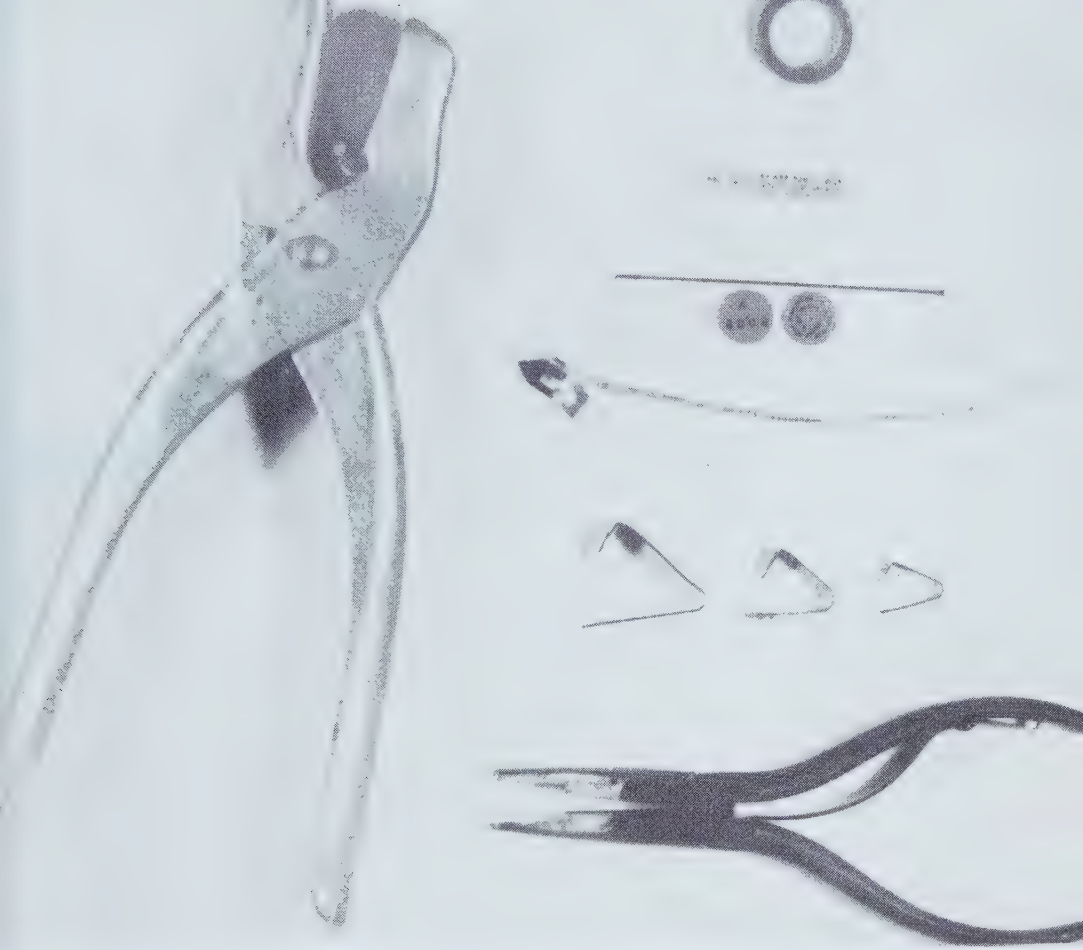
Another Scotsman, T. Wemyss Fulton, began experimental fish marking in 1889. Fulton tagged thousands of strictly marine fishes of many commercial species. Furthermore, he examined critically various materials that might resist the chemical action of sea water. Pieces of leather, gutta percha, india rubber, lead, copper, zinc, and brass were immersed in sea water for several weeks. Ultimately brass was selected as the most satisfactory substance then available. It was decided that the tag should be fastened around the tail of the fish. Thin brass circular disks, three-quarters of an inch in diameter, were used. Each disk had a consecutive number stamped on it and was pierced with two small holes by which it could be fastened to the fish with black silk cord which was selected as the best material for tying on the tag. Although on the average only about five per cent of his marked fish were recaptured, the experiments of Fulton yielded valuable information concerning the movements of some twenty-two different species of European food fishes.

Modern Fish Tags

Fish tags during the last quarter of a century have been generally of three distinct types, which, of course, are constructed and applied in various ways. These are the button or disk type, consisting of two disks attached by a shank of the same material or a wire and the strap tag, made of metal. Both of these types are attached externally to the fish. There is also an internal tag or belly tag which is placed inside of the body cavity of the fish. The first type as devised by

DIAGRAM *shows various types of tags and point of attachment to fish. A is dart tag. B is Petersen tag. C is cattle tag. D is internal magnetic tag.*



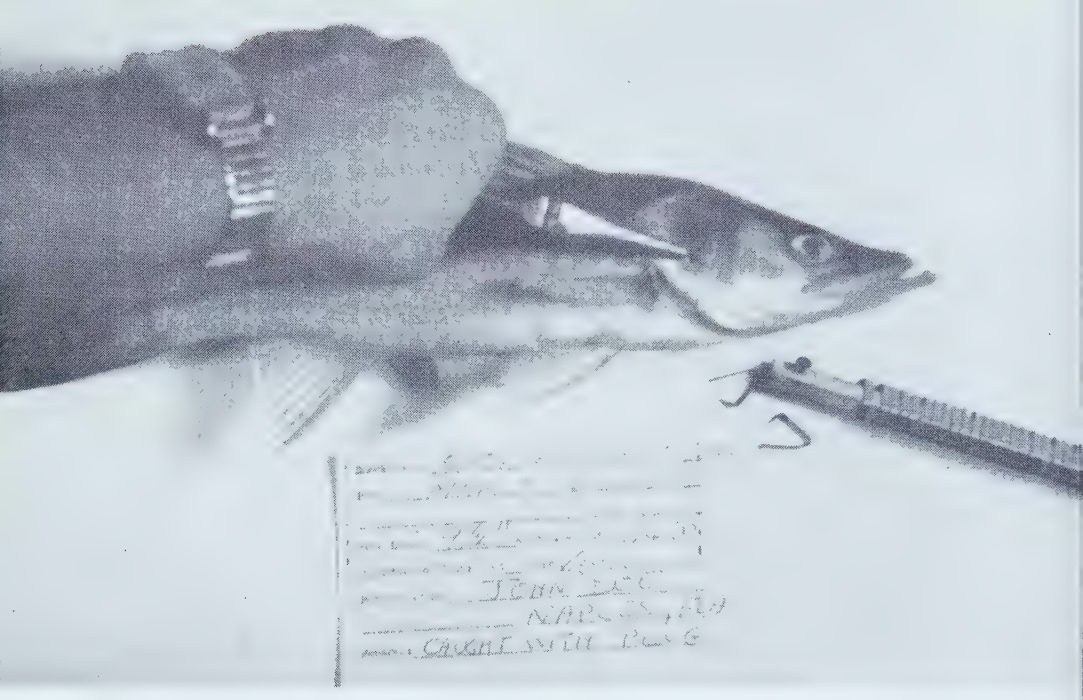


TAGS AND TOOLS *for applying them. Top to bottom, bill fish ring tag, crawfish tail tag, Petersen tag, dent tag, cattle tag. Left, pliers for cattle tag; right, pliers for Petersen tag.*

C. G. Petersen is one of the most popular. The Marine Laboratory at Miami has used it with success on mullet and snook. This tag consists of two brightly colored plastic disks which are attached to the sides of the fish by running a nickel pin through the muscles of the back, usually under the dorsal fin and then bending the ends in such a manner so that the disks cannot come off.

The second type of tag, often called the strap or cattle tag, was developed by Dr. C. H. Gilbert of Stanford University. This tag is essentially a metal clip fashioned after a type intended originally for earmarking cattle and sheep. It is attached either to the mouth, gill cover or the upper or lower lobe of the caudal fin by means of a special pair of pliers, which closes the clip.

A third distinct type of tag consists of a strip of colored plastic, properly labelled, which is pushed into the body cavity of the fish by making a small incision in the belly wall. This



METHOD *of applying cattle tag with special pliers. Supply of tags on stick shown to right.*

tag is not visible from the exterior, of course, but when the fish is gutted the tag comes to light and is readily recognized.

An interesting modification of the internal tag has been devised by Dr. Rounsefell for marking herring in Alaska. Small strips of metal, bearing the identifying numbers, were placed inside the body cavity of thousands of herring, and recovery was accomplished by electro magnets in the delivery machine of the processing plant. The metal tags, which are magnetic, were collected and held by the magnets, and since the locality of the fish in each day's run could be ascertained, the movements of the schools of herring from the point of tagging to the place of recapture were readily studied.

What Tag Is Best?

The best tag for any experiment depends upon several factors, such as the length of time that the tag should remain on the fish. The tagging of adult Pacific salmon in which the whole experiment can occupy only a few months can be accomplished with a strap tag, but the same tag is poor for immature salmon that will remain longer at sea. Body cavity tags have probably the best record for staying on fish, but because of the difficulty of recovery they are often excluded from consideration.

The Right Tag for Each Fish

Tags that remain well on one type of fish may be of little value on another. Thus, the strap tag, although excellent when attached to the gill cover of the halibut, has proved very poor on cod, haddock and pollock.

For soft-bodied fishes the celluloid body-cavity tag has been successful on the squeeteague and scup.

At Miami, where many game fish research programs are being carried out, the selection of the proper tag for some of these wild fighting and tough gangsters is recognized as a real problem. Tagging of the big bluefin tuna for instance presents special difficulties. The answer may lie in a type of tag contrived by a staff member. It consists of a nickel plated monel metal tuna hook stamped with a number and the legend "Return to U. of M. Marine Lab." The hook is attached to a 50 lb. test leader which in turn is fastened to a 3/16″ cotton line fastened to the stern of the boat. The giant tuna grabs the bait and is hooked. The 50 lb. test piano wire leader holds this powerful fighter just long enough to sink the hook and then breaks under the strain and our fish is tagged. Because of reports that the hook corroded in the flesh of the fish, they were later coated with a thin film of plastic.

Ring and Dart Tags

Sometimes a special problem may lead to the design of a special tag. This was the case with the sailfish investigation in Florida. The obvious desirability of releasing the fish quickly, combined with the long bill of the fish, suggested the idea of a rubber ring which could be quickly slipped over the bill while the fish was being cut loose from the wire leader with pliers. The ring was made of neoprene and provided with a numbered stainless steel tag for identification. Unfortunately Captain Whiticar of Stuart reported that a little while after the tagging started he began to take fish which had lost the end of the bill, possibly due to the action of the tagging ring.

Another type of tag used for sailfishes was originally applied off the Atlantic coast of North America to the bluefin tuna. This consists of a small metal dart to which is attached a plastic ribbon or tube. The dart fits over a metal pin on the end of a pole. In order to use it, the pole is held in one hand as the fish is brought alongside and the dart thrust into the muscular part of the fish. When the fish is released, the dart slips off the pole and remains in the fish. Unfortunately this also appears to damage the fish, judging from suspicious damaged areas found on captured fishes at the place where a dart might have been inserted. For the larger and more active gamefish the hook tag is still considered to have greatest possibilities, since it lessens the amount of time in catching the fish and releases it in better condition.

The Person Tagging

Tags such as the Archer and Peterson and body-cavity type should only be applied by a skilled tagger. In tagging a commercially caught fish such as the mullet this is easily accomplished. The tagger goes out with the commercial fisherman and tags the many fish caught in the net and releases them. In the case of game fish the biologist depends in many cases upon the game fish angler to help. Therefore, it is necessary to have a

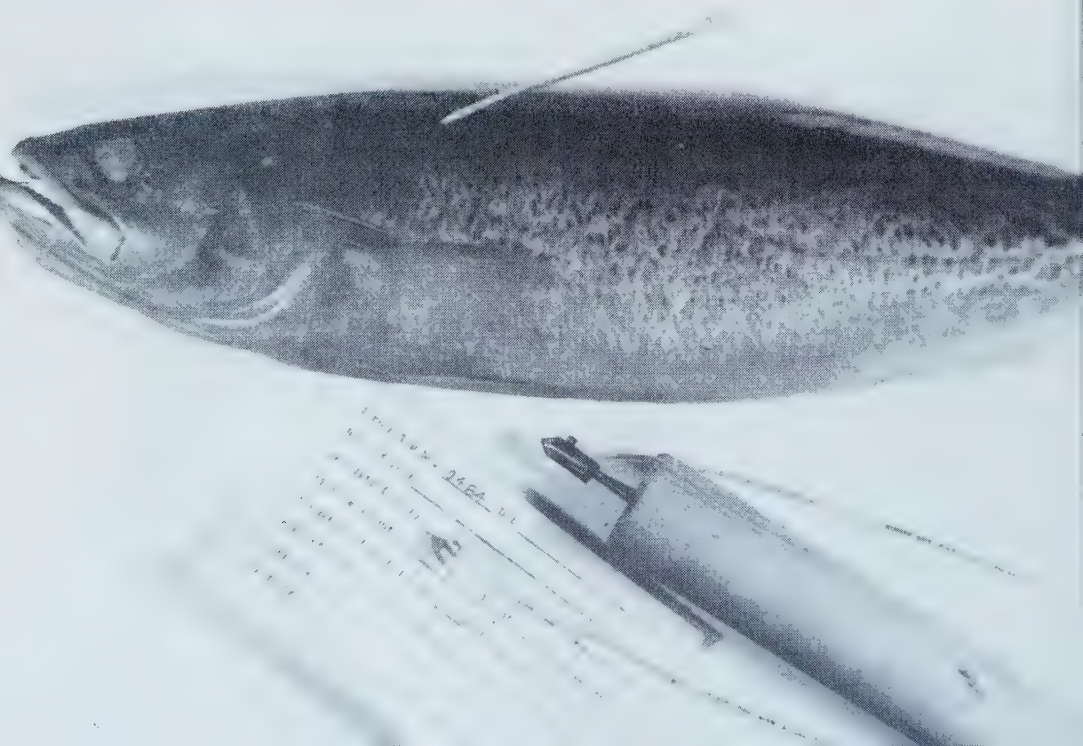
tag that is easy to apply, such as the cattle tag used in the Florida snook tagging program.

Influence of Capture and Handling On Type of Tag to Be used

The usual methods by which fish are captured and handled are important in the selection of a tag and its proper application. For species that are handled individually and cleaned at the time of catching there is a large choice of tags. A fair-sized brightly colored celluloid body cavity tag is easily found when cleaning. This would be a poor tag for the Atlantic coast mackerel, though, because this fish is shipped to the markets without cleaning, and tags returned from the markets do not give the desired information.

How are Tags Recovered?

Recovering tags is a very important part of any tagging program. It is also an expensive operation. The reward must be sufficiently large to act as an inducement. Rewards vary from 25 cents to $2.00 depending largely on the species of fish, the amount of information required, and the number of fish tagged. An advertising and publicity campaign is essential. This involves contacting anglers clubs and commercial fishermen at regular intervals, for people sometimes forget to turn in the tags. Printed posters, trade bulletins, newspapers, radio and TV are of invaluable aid at this phase of tagging. When Archer commenced marking Norwegian salmon in 1893, he fitted out a boat and personally canvassed outlying districts. Robert



METHOD *of applying dart tag. Dart is shown on holder at bottom. Above it is shown where inserted in fish.*

A. Nesbit in 1933 commenced the custom of printing full directions on celluloid Petersen and body-cavity tags. This included the address, notice of a reward and full directions on the reverse side of the body-cavity tags as follows:

State when and where caught or when and from whom purchased. Measure fish by tracing its outline carefully on paper. Send about 20 scales from each side of the fish.

The Purpose of Tagging

The ability to account for the presence of a particular fish or group of fish in time or space furnishes an important tool in fishery management. Happily, the day of marking fish merely out of general curiosity is almost past. Today, a biologist decides what information is needed to solve a specific problem. If marking of fish is indicated as a tool for this, it is so used. The reason for tagging is known. The numbers to be tagged, the sites chosen, the type of tag, season of tagging and so on are decided according to the problem to be solved.

Movement of Fish

As the recovered tags start coming in, the movements of the fish become evident and, in some instances, the speed of the movement. A fish tagged in Miami today and caught in Jacksonville tomorrow would indeed be a fast traveler. Some fish travel tremendous distances. A tagged albacore, released in California, was eventually recaptured in Japan. On the other hand returns to date from our snook tagging program being conducted for the Florida State Board of Conservation show movements of less than a mile.

USING *ring tag on sailfish.*

Ninety-one per cent of the mullet tagged by us around the thousands of miles of Florida coastline moved less than twenty miles, while the remaining nine per cent moved distances up to 350 miles.

Are They All One Population?

Tagging may sometimes be used to show the boundaries between groups or populations of fish of the same species. It is important in the management of a fishery to know if the species being fished is one population or several populations, for the intensive fishing of any area of a single population will affect the whole, while this same situation would affect one population in the latter case.

How Old Is The Fish?

Most fish are measured at the time of tagging, and several scales taken from the sides of their bodies. From the scales the biologist is sometimes able to determine the age of the fish in much the same way that we determine the age of a tree by counting the annular rings of the trunk. The recovery of tagged individuals from which scales are obtained before tagging and after recapture forms a valuable check on the validity of the age interpretations from the scales. Meas-

urements taken at the time of recapture will also show the amount the fish has grown. Dr. Paul Hansen, of Denmark, reports a cod recaptured 21 years after tagging.

Both age and growth are extremely important as a basis for any regulatory measures which may be put into effect. A fast growing fish with a short life span can be fished much more intensively than a slow growing fish with a longer life span, such as the halibut.

How Many Fish Are There In the Sea?

Tagging can even help to answer the question of how many fish there are in the sea. It is frequently used to estimate the amount of fish present in a fishery. An example might help to illustrate this point. Suppose we wanted to estimate the number of fish in a pond. We could tag 100 of them. If in our subsequent fishing of this pond we found that approximately one fish in nine caught was a tagged one, this would indicate a population of 900 fish in the pond.

Our pond experiment will also give us an idea of the mortality rate due to fishing. Suppose within one year after tagging our 100 fish we get 50 tags back. Since this is half of the total tagged, it would show a mortality due to fishing of 50% per annum, which in the case of a slow growing, long lived fish might cause serious depletion.

The International Aspect

Over thirteen nations of the world have officially engaged in fish tagging as part of their scientific fishery research, with most of the countries paying a reward for every tag returned. Such fishes as the Atlantic and Alaska salmons, codfish, haddock, halibut, flounders, brook trout, sea trout, striped bass, mullet and herring have been tagged, along with the common blue crab of the Atlantic and Gulf coasts, lobsters, sharks, sturgeon and eels. Many thousands of marine fishes are now being tagged along the Atlantic and Pacific coasts by fishery investigators.

How the Fishermen Can Help

Every fisherman can lend aid by promptly returning any fish tag which may be found. The return of the tags is fully as important as the technique of tagging itself and only with the cooperation of fishermen can the biologist succeed in this phase of fishery research. And the information which the biologist can give about the place and time of tagging is often interesting enough in itself to reward the angler for his assistance.

For Further Reading

Fishery Science, Its Methods and Applications, by George A. Rounsefell and W. Harry Everhart, 1953. John Wiley & Sons, Inc., New York and Chapman & Hall, Limited, London. The authors of this book have combined their rich and varied experiences in the field of fresh-water and marine fisheries and produced a very readable and realistic summary of the better methods and procedures for solving the problems affecting marine and fresh-water fisheries. This book will be of interest to biologists, sportsmen and commercial fishermen.

UNESCO And The Marine Sciences

By MASAO YOSHIDA
Natural Sciences Department
U.N.E.S.C.O.

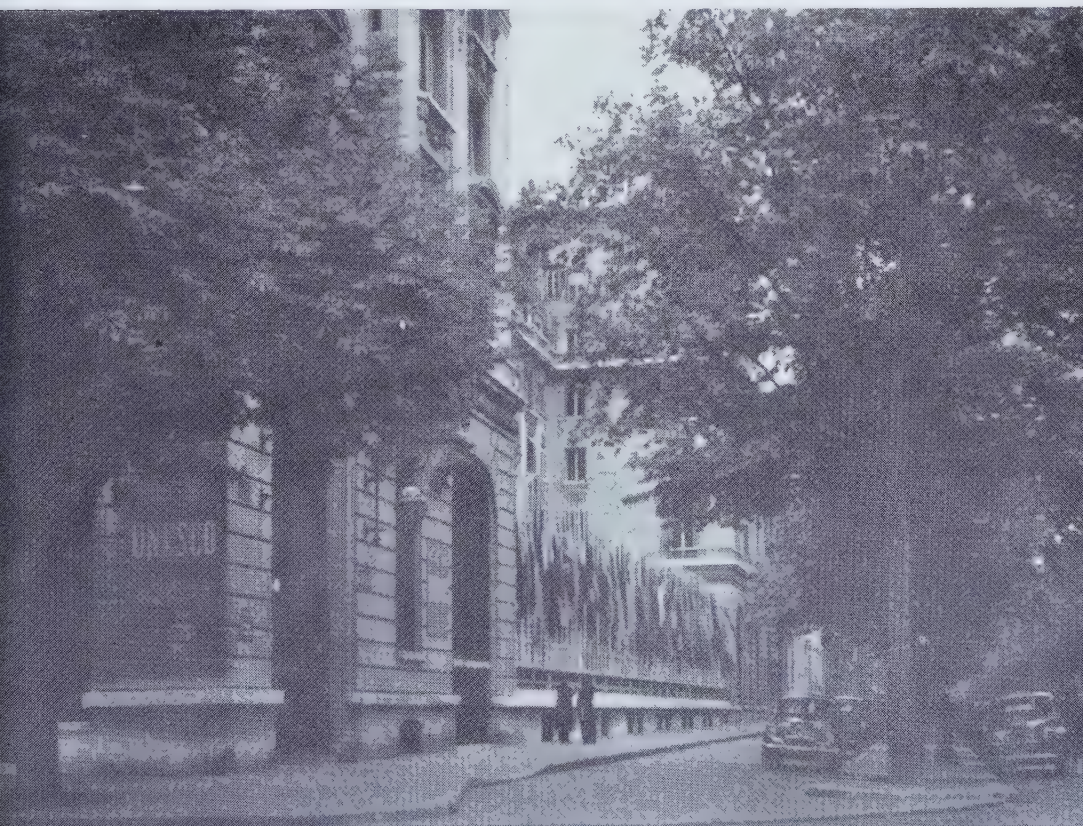
THE APPROVAL in November 1955 by the UNESCO Executive Board of the statutes of the International Advisory Committee on Marine Sciences has cleared the way for UNESCO to offer its services to the world's scientists in all fields who apply their studies to the solution of problems related to the oceans.

UNESCO could not have chosen a more appropriate domain to which to extend its activities, since, as pointed out by the interim committee meeting held in Tokyo last October, "The oceans are international and hence the marine sciences are a natural field for international collaboration. No one country can find out all it needs to know about the sea except through the co-operative activity of many countries."

Growth of an Idea

The following paragraphs give a brief sketch of the lines which the UNESCO Marine Sciences Program has followed and the possible

The UNESCO Building



developments which might ensue in the future.

The first instance of UNESCO's interest in aiding marine research might be traced to a meeting of three people in Djakarta in 1951. In April of that year, Dr. Alexander Wolsky, representing the UNESCO Science Cooperation Office for South East Asia, discussed with Dr. G. L. Kesteven, then General Secretary of the Indo-Pacific Fisheries Council, and Dr. J. D. F. Hardenberg, also from IPFC, the proposal for establishing an international oceanographic institute for the Indo-Pacific region. Developments from the ideas conceived at this meeting resulted in a resolution of the IPFC, which was transmitted to UNESCO by FAO in October, 1952.

Later in the same year, a delegate from Japan drew the attention of the General Conference of UNESCO at its Seventh Session to the importance of promoting marine research as a contribution towards better standards of living.

Coordination and Training

No brick-and-mortar establishment materialized out of these moves, though it was favorably viewed by a meeting of experts convened by UNESCO in 1953 to consider the matter. Later developments brought the difficulties more and more to the foreground, and the mode of approach to the problem of helping marine research was altered—to a policy of trying to achieve a gradual development, by concentrating first on the co-ordination of national research programs and on training of specialized personnel.

The UNESCO Marine Sciences Program was conceived for the first time in its present form in 1954 by the General Conference at its Eighth Session in Montevideo, based on a report inspired by a draft resolution submitted again by the Japanese delegation: An International Advisory Committee on Marine Sciences was to be established to advise UNESCO on plans "directed to the stimulation and better co-ordination of basic research in physical oceanography and marine biology."

Need for Communication

There is one answer that meets the call both for "stimulation" and "better co-ordination" in scientific research: It is *communication*. For the research worker to know what has been accomplished and what is being done in his line of study by others in all parts of the world, while giving him cues as to what approaches are left for him to follow in his own work, at the same time provides a stimulating challenge to try new ways that may lead to success where others have failed.

The two effective practices in the scientific world for promoting communication are: *Publication* and *scientific meetings*. While no explanation is needed of the function of scientific journals as the medium of communication between scientists, these alone cannot convey all the necessary information from the authors to those who may be interested in utilizing their experiences. Even correspondence may not be enough; sometimes

direct personal contact and discussion is the only answer to the need of the research workers spread all over the world to compare notes with each other about their common interests and objectives. Scientific meetings, particularly of the kind called symposia, are forms devised expressly for providing such personal contacts, in a collective manner. At such meetings, the participants not only meet their colleagues with whom they have already maintained a long acquaintance by mail, but also make new friends, with whom collaboration on a new theme or a new approach to an old theme might be initiated. Symposia are organized by individual institutions, by associations of institutions, by scientific societies, or by international organizations. Many international organizations exist which on occasion call together symposia to discuss specific topics related to the marine sciences. If the symposia are of a nature that fits into the UNESCO Marine Sciences Program, they might on request be assisted financially and otherwise by UNESCO. An example is the *"International Conference on the Comparative Biology of Marine Species studied in Different Districts of their Area of Distribution,"* sponsored by the International Union of Biological Sciences and held at the Roscoff Biological Station in Brittany, France, 27 June to 4 July, 1956. UNESCO paid the travel expenses of some of the delegates attending from outside France.

Importance of Plankton

On other occasions symposia must be organized by UNESCO on its own. These are symposia on subjects in particular conformity with the UNESCO Marine Sciences Program. One important mission of this Program is to bridge the gap between basic research and practical application. For instance, we know that plankton constitutes the initial link in the long food chain that may be said to terminate with man eating the fish that eat smaller fish, that eat . . . and so on until we come back to the tiny fish which eats plankton. These in turn get their food, or rather build it up with the aid of sunlight, from water, air dissolved in the water and the minute quantities of dissolved minerals. Marine biologists in the course of time have collected, named and studied a vast variety of planktons. Yet we still know far too little about exactly where, how and why certain planktons play their role in certain series of food chains. So UNESCO believes it necessary to organize symposia on the plankton, not for comparing notes about new and unknown species of plankton, but for trying to find out the means of studying their position and function in the vast and complicated underwater world. Two such symposia have already been sponsored by UNESCO in the past: in January 1954, in Bangkok, Thailand, and in November 1955 in Sao Paulo, Brazil.

Selection of Meeting Places

There is a reason for UNESCO's holding these symposia in Bangkok, or in Sao Paulo, in preference to more "centralized" locations like Eu-

SOME OF THE *fantastic microscopic life of the sea, known collectively as plankton. The thin, transparent, eel-like creatures are the rapacious arrow worms. Smaller, more opaque creatures are the copeopods, most important food of the invisible world of the sea. Photographed under the microscope.*

rope or North America. If it were purely for promoting advances in applying scientific knowledge, some big center of oceanographic or biological research in a European country or the United States would naturally be selected for the convenience of attendants, but another objective which UNESCO must never lose sight of is to stimulate research in regions where scientific levels have not attained their potential limits in comparison with more developed countries. That is one reason why last October the first gathering of nine world experts, who have eventually formed in large part the UNESCO International Advisory Committee on Marine Sciences, was held in Japan. On this occasion advantage was taken of the presence of these experts to hold, apart from the Committee sessions, a regional *Symposium on Physical Oceanography,* which proved to be an undoubted stimulus to Japanese oceanography, while the participants from twelve countries in the Indo-Pacific Region were also able to return to their respective institutes with more ideas than they had come with.

The next Advisory Committee meeting is planned to be held during the week of October 22, 1956.

World Directory of Marine Science

With regard to publications, it is hardly necessary for UNESCO to add yet others to the many and varied examples that already exist in periodic or in book form, from the highly specialized ones to those intended for the general public, that have more or less connection with the marine sciences.

In spite of the profusion of existing literature, or perhaps because of it, gaps are to be found, which UNESCO might help to fill. For instance, several organizations and institutions have issued directories of marine scientists and institutions, but all of them cover only certain parts of the world, or certain fields. Simply gathering together the already available material scattered among all these different directories could yield the bulk of the material for a comprehensive world directory of marine science and fishery institutions, which should prove of great reference value to research workers.

Bibliography is another item that is becoming more and more of a problem *because* of the bewildering array of available printed information. Though UNESCO does not have the means of undertaking bibliographical work as part of its own activities, it may in time be able to sign an agreement with an appropriate organization to carry out the work on behalf of UNESCO.

Scarcity of Trained Scientists

One matter which was given much attention during the discussions at the Tokyo meeting mentioned above was the chronic shortage of trained research workers in regions where marine science needs to be set on foot. Experts might be sent to these regions from advanced countries, but they at once hit against a wall when it comes to recruiting assistance to help them in collecting specimens or making oceanographic measurements, or with work in new laboratories that

may be set up by local governments. The problem of training specialized personnel is likely to become the major headache of the expert when he is expected to accomplish his mission within a fixed term of years and return to his country, leaving the further development of local marine science in the hands of his locally recruited "disciples".

Some of the Committee members who met in Tokyo thought that the only way for scientists to form competent assistants was to pick out promising university graduates with a broad background of basic scientific knowledge, and to train them themselves in the specialized work—there was no quick way of producing assistants: The universities were to produce good but unspecialized "raw material", to be moulded into specialized marine scientists within the marine laboratories.

Training Courses

Against this, others, especially those of the Indo-Pacific region, pointed out that the situation in the region was so acute that something *must* be done to ease the dearth of research workers in these regions. One practice designed to meet such situations is the training course: a selected group of trainees is gathered from surrounding countries to follow courses on certain aspects of practice or theory in one of the many branches of marine science. Trainees may as often as not already be experts in adjacent fields of science. In fact, in one very successful training course which lasted a month, held in November 1955 in Sao Paulo, Brazil, some of the trainees took turns to serve as lecturers and instructors when it came to subjects in their own particular line of specialization.

This course was a very ambitious one covering both marine biology and physical oceanography, and was organized by the UNESCO Science Co-Operation Office for Latin America, Montevideo, in collaboration with the University of Sao Paulo, where the course was held.

Fellowships to Aid Students

When a promising research worker has learned all he can learn in his country about his own work, the time comes when people start thinking of sending him abroad for more knowledge and experience. More often than not the money cannot be found. All the United Nations Agencies, including UNESCO, have funds allocated in their budgets to help in cases where the subject of study is pertinent to the programs operated by the Agencies. UNESCO has already awarded three fellowships in the marine sciences since the program went into action in 1955. One was given to a Brazilian marine biologist for a six-month study of plankton, her time to be divided between France, England, Denmark and Holland. Another enabled a Japanese maritime meteorologist to learn about electronics applied to oceanographic instrumentation in

TRAINING COURSE *in marine science at Sao Paulo, November, 1955.*

OPENING SESSION *of the* UNESCO *marine science meetings in Tokyo, October, 1955.*

England. The third fellow, from India, will study plankton migration and light penetration in seawater at the Woods Hole Oceanographic Institution, under Dr. Ketchum. The last two fellowships are for one year.

Advisory Committee

To assist UNESCO to plan intelligently the activities of its Marine Sciences Program, with the interests in view of all the different scientific fields that can be applied to the study of the ocean and of all the different areas of the world's oceans, was the object of the establishment by UNESCO of the International Advisory Committee on Marine Sciences.

The statutes of the Committee provide for its meeting at least once a year. It is composed of nine members, who have a term of three years, staggered so that three members retire every year unless re-elected. The present members come from Australia, Cuba, Denmark, France, India, Japan, United Kingdom, U.S.A. and U.S.S.R.

All requests that may be presented to UNESCO from its Member States, the specialized agencies of the U.N. such as the Food and Agriculture Organization, or other international or regional organizations interested in UNESCO's program, are considered by the Committee.

International Research Vessel

At other times the Committee itself may initiate projects, such as was the case when, at the Tokyo meeting of

October, 1955, it recommended that UNESCO study the feasibility of operating an international oceanographic research vessel which could be engaged in activities independent of the interests of any single country, to fill the gaps in the present knowledge of oceanic areas and also in the training of research workers from countries needing to build up their laboratory personnel.

UNESCO is keeping in close touch with the U.N. Food and Agriculture Organization, the International Council of Scientific Unions and its constituent scientific unions, in the matter of its Marine Sciences Program, and hopes that the program will fill the need for a continuing stream of activities to promote and stimulate the scientists of all countries to an interest in applying their studies to the solution of problems related to the seas.

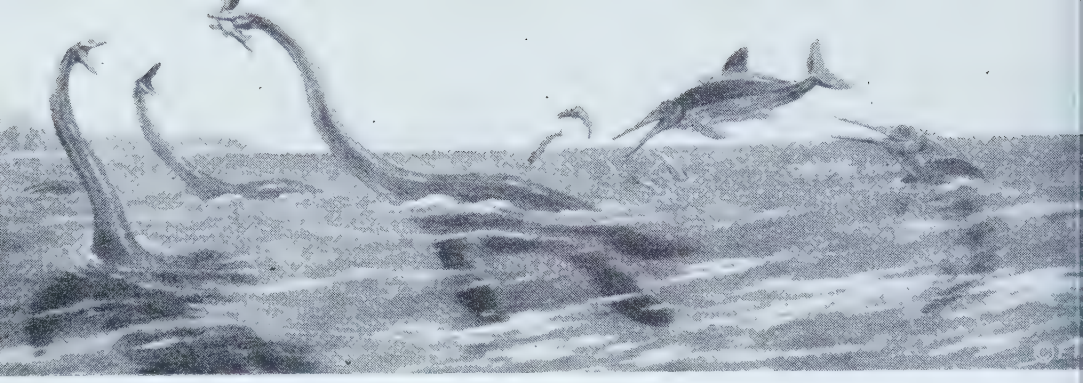
Former World Record

THE PICTURE ON the back cover of this issue draws attention to the Bahamas, where the Foundation will hold the first international conference between anglers and marine biologists on November 27th. The fish will be recognized as a blue marlin, one of the heaviest and most spectacular of game fishes in this area. It was caught by Mrs. R. M. Hodgson of Detroit, Michigan, and stood for one year as the world record for women on 9-thread line at 218½ lbs. Mrs. George Lyon, Jr. and Captain John Cass, are on the flying bridge.

For Tomorrow

DURING THE COMING YEAR it is hoped to increase the size of the Bulletin so as to include more news features. Articles will cover a wide range of explorations and scientific discoveries related to the sea. They will include the story of the invention of ships' bottom paints, the battle against shipworms, new plans for deep-sea exploration and reports on the work of marine laboratories and research ships throughout the world. New minerals from the ocean and the giant life living in the sea today illustrate the range of topics.

Should you have suggestions, the editor would be glad to hear from you. If you have friends interested in the sea, why not give them a membership for Christmas? With increased membership the Bulletin will be able to improve its style and contents and, it is hoped, eventually become a full color monthly.



ANCIENT SEAGOING REPTILES, *the plesiosaurs and ichthyosaurs, the latter looking like large, fierce porpoises.*

Monsters of the Ancient Seas

By F. G. WALTON SMITH

THE ANCIENT GREEKS and Romans wrote of fierce monsters in the ocean, huge and hideous, yet seemingly rare enough inasmuch as no one could really describe them except in the vaguest and most improbable terms. As the centuries passed by, tales of sea monsters continued to appear, most of them obviously copied from earlier authors, but a few with a sparkle of originality and with a freshness of circumstance that encouraged the natural credulity of our forefathers. Even today such stories appear at intervals and when due allowance is made for hoaxes and unreliable witnesses there still remains a residue of observation which cannot easily be explained in terms of the living sea creatures known to science, but which equally well cannot be dismissed as optical illusions or deliberate falsehoods.

Fossil Comes to Life

Some have sought to interpret the reports of huge sea serpents and other marine monsters as proof of the survival of some prehistoric creature. Unlikely though this may at first sight appear, yet in recent years some measure of support for the possibility has unexpectedly come forward. The discovery in 1939 of an odd looking fish in the catch of a South African trawler and its later identification as a coelacanth, one of the supposedly extinct lobe finned fishes which were known to have lived as far back as the Devonian period between 200 and 300 million years ago, has given new stimulus to this type of speculation. Once the existence of a living coelacanth became known, several other specimens were later found, even though fishes of this kind were previously believed to have been extinct for over 50,000,000 years.

There are other arguments in favor of the presence in the sea today of monstrous prehistoric fishes or reptiles or the bizarre ancestors of squids and octopuses, whose only signs of ex-

istence are occasional chance encounters with ships and men which have led to the sea monster legend. Failure to capture or to preserve them for scientific study is no obstacle to those who believe in them. In the first place, the devices used by fishermen would probably not serve to catch very large creatures. Moreover, if the creatures in question lived below the upper one or two thousand feet of water, they would not be disturbed by fishing since commercial fishing lines and nets are not set so far below the surface. As for scientific exploration, the difficulty of catching a large and active creature in deep water has been compared to the problem that would be faced by an interplanetary expedition investigating life on earth if the space ship could not approach the surface of the earth any closer than an ocean vessel may approach the bottom of the deep sea. On ship one is unable to see the deep sea floor. The same difficulty would face the space ship, if the air below were filled by impenetrable fog.

Hard to Catch

Under such conditions, the explorer from space who attempted to find out what kind of animals live on earth two miles below his ship would have to use nets to study life in the dark depths of the air below him. Nets and

THESE PRIMITIVE *crustaceans of monstrous shape, the trilobites, swarmed in the Cambrian seas during the oldest period known to sustain life. Sponges and jellyfishes are also shown.*

traps dropped down even into the populous cities of London or New York would scarcely be likely to catch a human being unless he were particularly lethargic or blind. Imagine then the likelihood of a net towed at random at any part of the earth catching an animal with a good turn of speed, and good eyesight, such as a bird or antelope. If the animal were a rare species the chances of collecting one even after extensive but random netting over a wide area of the globe would be negligible. And so is our chance of catching large and active prehistoric monsters if they should exist only in the deep sea.

The history of life in ancient seas, preserved in fossil remains and interpreted by scientific method may not give much encouragement to the idea that the fierce saltwater reptiles of the past live today. The evidence is that they ceased to exist many millions of years ago. But it is negative evidence. The strange case of the South African coelacanth, found alive, today, even though there is a complete absence of fossil records to show its continued existence during the past 50 million years, is a dramatic reminder of the weakness of this argument. There are billions of living creatures in the sea today. A single fish may produce millions of eggs. Yet when death comes to each of them, this prodigious army of corpses virtually disappears by decay and disintegration, or as food for others. By accident some few are preserved under exceptional circumstances, such as by immediate burial in the mud of shallow waters and so they become fossils. Most of the fossils are buried deep in the rock beneath later deposits of sediments and all are subject to the destructive action of the great mountain building movements of the earth's history with intense heat, crushing and folding of rocks and the erosive action of water. It is little wonder that the fossil record of past life is incomplete.

Search for Sea Monsters

Dr. Anton Bruun, Danish biologist and expert on marine life, is one of a number of scientists who, impressed by the inadequacy of our knowledge and explanation of deep sea life, feels that there is a real possibility of a properly planned and equipped expedition finding the sea monster. He is quoted as saying recently:

"In my opinion no one has ever caught a sea serpent because it requires a special fishing technique. I have no doubt that such a monster could be caught . . . "

There are many marine biologists who would hesitate to agree to this without reservations. But it may be worthwhile looking into the past in order to discover what kind of creatures have formerly lived in the sea which like the coelacanth might have survived without fossil evidence and which could be the basis of the sea monster story, or which might, some day, by unexpected appearance, give rise to newer and more fantastic tales.

The first stirrings of life in the lonely primal seas of nearly a billion years ago were of insignificant appearance yet they were the beginning of a long procession of countless

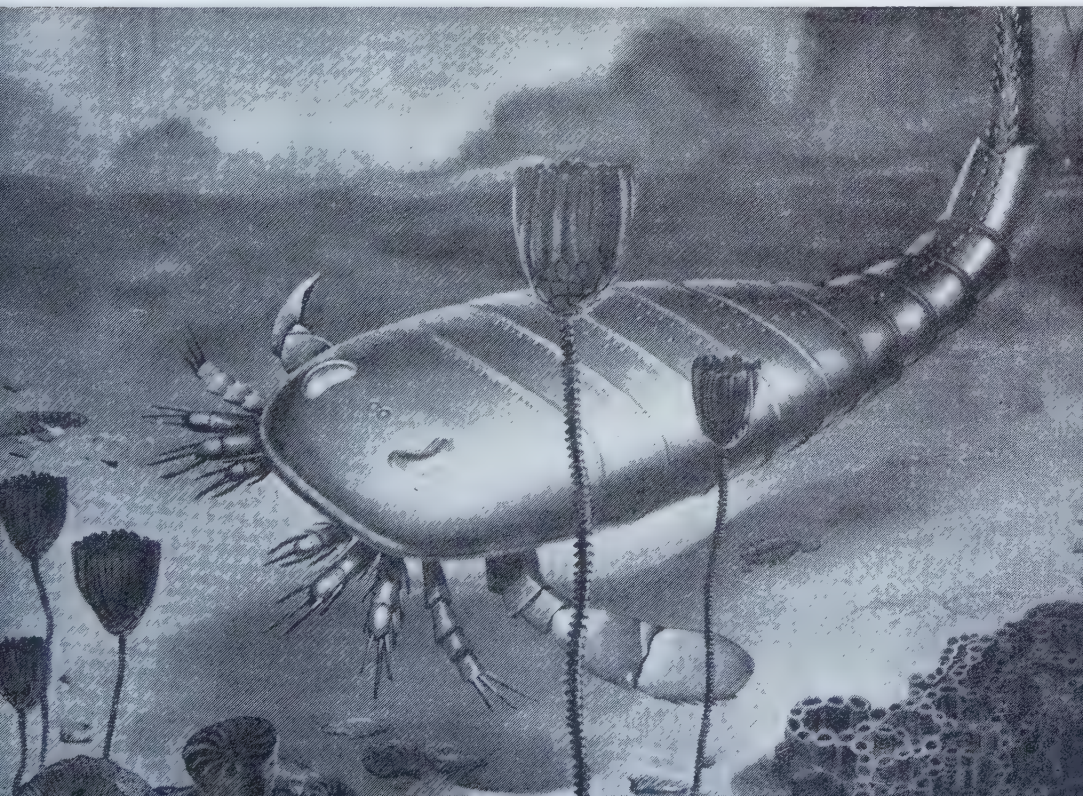
generations of every shape and form of animal during which there came and went many creatures who, by monstrosity of shape and form, claim our attention here.

The early sea animals were insignificant sponges and worms and it was not until later, about 500 million years ago in fact, that there appeared the first of the arthropods, that great group of jointed shell animals which includes the insects and crustacea or crabs and lobsters. Though they never grew to be more than 29 inches long yet the trilobites as they are called were strange enough in appearance and would certainly cause astonishment if they were found in the ocean today, with their superficial resemblance to an oversized pill bug or wood louse. But although they existed for a period of one hundred times the entire span of the human race, the fossil evidence shows that after crawling on the sea floor for about 300 million years they died out in the Permian time. There are no traces of their existence during the past 200 million years.

Nine foot Sea Scorpions

More likely candidates, by reason of size, for inclusion among sea monsters are other members of this group, the sea scorpions, which were being evolved after the trilobites had already begun to pass their climax. Although most of these creatures were small,

DURING A *geological period over 300 million years before our time there existed the sea scorpion, a monstrous creature which sometimes reached nearly 10 feet in length. This sea scorpion, named* Eurypterus remipes, *under two feet long, is seen swimming among flowerlike animals known as crinoids.*



a few of them grew to a size that would make an encounter with them, on a present day seashore, startling, if not actually terrifying. The largest and most aggressive has left evidence in fossil form in western New York State, which shows that it had a total length of over 9 feet. The head end of this creature was provided with toothed pincers nearly three feet long and its general shape was between that of a scorpion and a lobster. The fossil record shows that these carnivorous creatures became more and more used to fresh-water, until they died out about 200 million years ago. Except for their fossil remains there is nothing to remind us today of the sea scorpions except the land scorpion, which seems to have evolved from them by comparatively small changes. Certainly we cannot, with any conviction, relate these long extinct monsters to the lobsterlike giants of the North Sea pictured by ancient writers.

Sea Devils

Among the lower groups of animals, some of those most fitted to be classed as sea monsters are the ancestors of our present day sea devils, the octopus, squid and nautilus, which have a long and ancient history reaching back nearly half a billion years. They are all, living and extinct, classed by scientists as cephalopods.

The first of these creatures to appear in the sea were not, like the squid and octopus, naked, but were protected by a shell. Today only in the Indian and western Pacific is there an animal, the *Nautilus,* to represent the

THE HUGE *sea scorpions, or Eurypterids, in some cases had powerful claws and must have been a great source of danger to all creatures of the sea, since they grew to be 30 or 40 times the size of the land scorpions of today.*

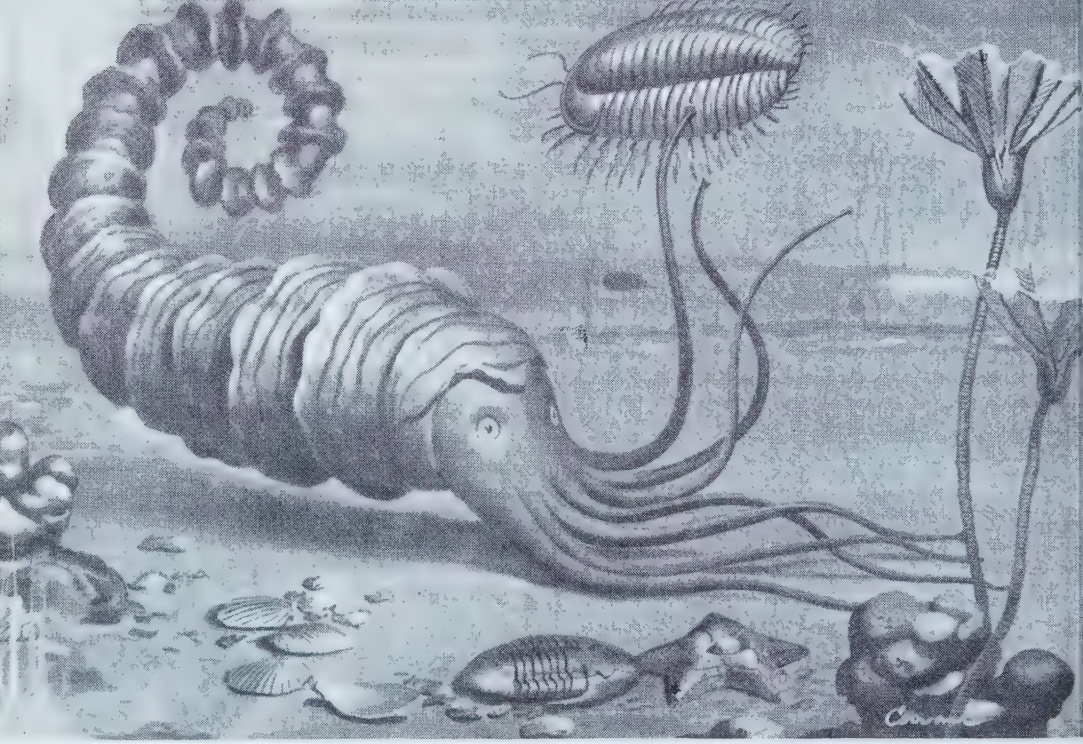
ancient shelled forms. The *Nautilus*, however, has a spiral shell, coiled on itself, whereas the early nautiloids had either straight or slightly curved shells. Among these was the extraordinary *Endoceras* with a long, straight, tapering shell fifteen feet long. With its extended tentacles, its large and efficient eyes, and the long slender shell like a spear behind it, this ancestor to the octopus must have been a terrifying though clumsy sight as it crawled or swam in the Ordovician seas.

Huge Creatures with Shells

As the millions of years rolled by, the many kinds of nautiloids gradually died out, to leave only the *Nautilus*, which has survived until today. Before doing so, however, some of them gave rise by evolutionary processes to two other kinds of sea devil, one of which is the ancestor of the present day octopus and squid, while the other, known as the ammonite, became for a while the most prolific creature in the seas. Ammonites were also inhabitants and makers of coiled shells, though of a different and more complicated pattern to those of the nautiloids. In the geological period known as the late Jurassic, some of these grew to a giant size, with shells formed of a flat coil up to ten feet in diameter, from the mouth of which protruded the octopus-like body and tentacles.

Both nautiloids and ammonites were predators, although their clumsy shells must have hampered rapid

A PAINTING *by Charles R. Knight shows a sea beach as it might have been about 400 million years ago. On the beach is a stranded specimen of the giant sea devil,* Endoceras.



SEVERAL HUNDRED *million years ago the trilobites continued to live in the ancient seas, but they were joined by sea devils with spiral shells, decorated by frills, as shown in the illustration. Eventually, some of these monstrous forms grew to a very considerable size. The flowerlike growths are animals known as crinoids, related to the starfishes.*

movement, except for one thing, their buoyancy. As the shells grew in length from the open end, the animals withdrew from the innermost part of the shelly tube and secreted from the innermost part of their bodies a wall or partition which closed off the older part of the shell as a chamber, filled with gas. As the animal grew older the shell grew in straight or spiral fashion and the number of chambers increased. Because of the gas within these chambers, the shells provided buoyancy to their owners. But, with the solitary exception of the present day *Nautilus,* these weird creatures of the ancient seas have left nothing in the fossil rocks to indicate their existence since over 70 million years ago. There is nothing in myth or legend which equals in imagination and originality the design of these ancient sea devils.

The present day squids, though naked, still possess the remains of a shell, but it is hidden, embedded within the flesh. Naked devil fishes of this kind first appeared as far back as 160,000,000 years ago. The belemnites, as they were called, probably never exceeded five or six feet in length but they were nevertheless fearsome creatures with large and

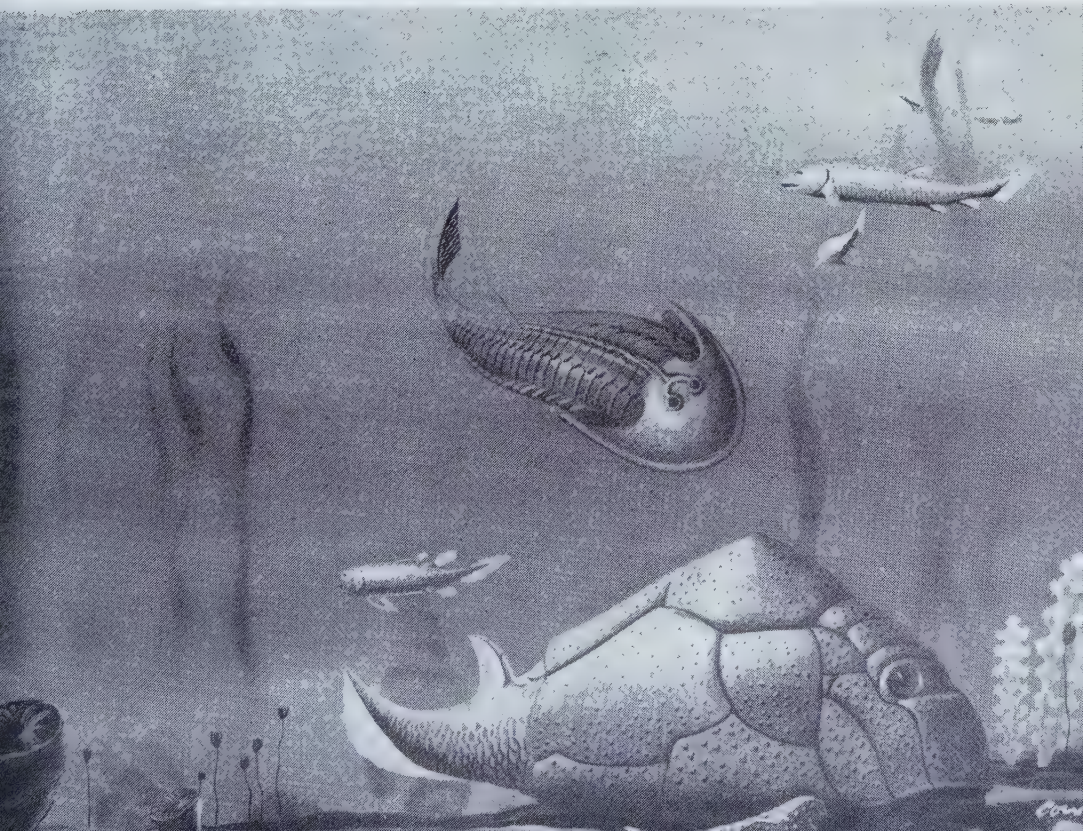
highly efficient eyes and with hooks instead of suckers on their tentacles. Like the modern squid, some at least of the belemnites were provided with ink sacs and were able to throw out a submarine smoke screen for attack or defense.

Except for the fishes, reptiles and whales few other sea animals of the past were truly monstrous, although occasional curiosities occurred which would seem startling if encountered in the sea today. In Jamaica, for instance, remains have been found of fossil bivalve shells attached to the ancient reefs, which grew so that they projected 5 feet outwards from the rocks. Only the giant clam, *Tridacna,* of the Pacific compares to this today.

Armor Plated Fishes

The evolution of fishes and from them of reptiles and mammals brought a new range of monstrous creatures to the ancient seas. The early fishes were monstrosities in shape and form rather than size, though. Not only did they lack jaws and typical fish scales, but the head and a varying extent of the body were covered with a kind of bony armor. From these fishes various other groups began to evolve.

One of the most striking of these groups consisted of sharklike fishes, one of which, *Titanichthys,* reached



THE STRANGE *and monstrous ancestors of today's fishes appeared while the first crustacea, the trilobites, were still swimming in the seas over 250 million years ago. Their bony armor gave them a fantastic appearance, surpassing some of the products of today's imaginative science fiction.*

about 20 feet in length. This shark also possessed a bony shield at the head end. Its mouth was heavily armed not with teeth, but with sharp cutting surfaces formed by the edges of the jawbones themselves. In order to close the mouth, the entire upper part of the head moved, instead of the lower jaw. Since the skull was nearly three feet across, the closing of this monstrous jaw had something like the effect of the huge mechanical shears used in cutting sheet metal in manufacturing plants.

Fishes like *Titanichthys* eventually died out, over 200 million years ago, but before this happened another group of fishes appeared which was eventually to give rise by evolution to all modern fishes, and also to the first of those air breathing fishes from which all of the amphibians, reptiles, birds and mammals have developed. Within this group was one particular type, the coelacanth. It possessed lobed fins which are the forerunners of the legs and arms of higher animals, and was thought to have become extinct at least 50 million years ago. This belief was exploded with the discovery of the coelacanth, *Latimeria,* off the east coast of South Africa.

Giant Fishes

Other fishes which were alive in the far past were sharks with jaws adapted to crushing shells, like the Port Jackson shark of today. During the Mississippian period of geological time over 250 million years ago there were nearly 300 species, so that the seas of that time must have been infested with them. The modern type of bony fish really began to appear in force at a later date and by the time the Cretaceous period was reached, 70 million years ago, some of them were very large. *Portheus,* for instance, whose fossil is found in New Zealand, reached a size larger even than the bluefin tunas and marlins or swordfish of today.

The history of ancient seas was one of slow, but nonetheless, dramatic change. First of all the trilobites came in to spread over the shallow sea floors as the dominant form of sea-life. They were joined by a minor wave of sea scorpions. Later they became overshadowed by the growing numbers of nautiloids and ammonites. Then came the highly predatory belemnites and the waves of newly developed fishes to take more and more important positions, preying on the more ancient trilobites. The last great wave of fiercely aggressive predators was the most violent, when the reptiles took possession of the seas, only to die out in turn when modern types of fishes replaced them.

40 Ton Monsters

Reptiles evolved first of all on land, where they eventually grew into the most monstrous and terrifying creatures that the world has known. Then some of them returned to the sea where they became the marine counterparts of the frightful tyrannosaurs and other predatory giants of the lands. The dinosaurs grew to be the largest land creatures the earth has ever seen, up to 80 feet long and 40 tons in weight, but none of them with

FOSSILIZED *jaws of a crocodile-like reptile, or phytosaur, found near Gywned, Pennsylvania.*

a brain weighing more than one pound. The seagoing reptiles did not reach these colossal sizes, for the modern whales and squids still have the record for size at sea. Nevertheless, during their day, the marine ichthyosaurs and plesiosaurs by number and ferocity established their reign.

Some of the earliest reptiles to return to the water had a superficial resemblance to modern crocodiles. These phytosaurs were sufficiently successful to reach a length of 25 feet, but apparently lived almost entirely in fresh-water streams and did not successfully invade the sea. While they were dying out at the end of the Triassic period, 170,000,000 years ago, the true sea reptiles were increasing in number and during the Jurassic and Cretaceous periods, extending from 170 to 70 million years ago, they were the monsters of the ocean, until they in turn began to die out. Among the first of these were the ichthyosaurs, literally the fishlizards, whose remains have been found in ancient sea deposits from California to Germany and Australia. These reptiles were so well preserved in the black shales in Württemberg, Germany, that the outline of skin and flesh remains as well as the bones. In fact, in several cases, a litter of young ichthyosaurs was found within the frame of the adult, indicating an ovoviviparous habit.

Some of these creatures were immense in size, up to 30 feet long and they resembled in general appearance the giant bluefin tunas except for the long narrow beak with its sharp conical recurved teeth. Being reptiles rather than fishes, they breathed through large nostrils. Their dorsal fins, though fishlike in appearance, had no internal rays or spines for support. Their eyes were large and powerful. With a body well adapted for speed and with a formidable mouth, the ichthyosaurs were able to feed readily on the fishes and belemnites and ammonites of their time and un-

doubtedly were responsible in a measure for the extinction of the ammonites and belemnites. One fossil ichthyosaur had over 200 belemnites in its stomach. Altogether they were fearsome monsters even to the monstrous detail of having the bones of as many as eight or nine fingers or toes embedded in their paired fins.

The huge but clumsy plesiosaurs, which lived at much the same time and ate much the same food as the ichthyosaurs, were quite different in appearance. Instead of a fishlike head with no neck, the head was small and the neck in some cases quite long. The body was broad and rather flat and had no tail fin. Instead of paired fins there were two pairs of paddles. Their behavior in motion must have been like that of a large turtle, but the long neck may have made up for the clumsiness of the rest of the body, by permitting quick movements of the head. Some of the largest of them were fifty feet in length, so that, along with the ichthyosaurs, these extinct marine reptiles would create considerable excitement if it turned out that some of them still existed in the deep waters of the ocean today.

3 Ton Turtles

There are several other types of reptile which lived during the time when reptiles ruled the seas. One is a giant turtle, *Archelon,* which reached 11 feet in length, 12 feet across the flippers and over 3 tons in weight. There were also crocodiles up to 20 feet in length, the *Thallatosuchia,* but these are not identical with the modern crocodiles. The turtles, in fact, are the only marine reptiles of those times which seem to have survived until today.

We have still to mention the most aggressive of all, and these are the sea serpents themselves. Although not true snakes, they fit remarkably well into the general idea of sea serpent stories. Although they have not been found as fossils since the end of the Cretaceous era, 70,000,000 years ago, they were at one time common over a wide range of seas, including New Zealand, France, Germany, Holland, Belgium and over a considerable part of the United States, where the seas of those times spread out over the continent.

Sea Serpents

The sea serpents, or mosasaurs, grew to be as much as 40 feet long. They had scales like a snake. Their jaws also had hinges or joints, one at the middle of the chin and two at each side, which allowed the mouth to gape very widely, and to swallow very large animals. On the other hand, unlike snakes, they possessed small limbs in the form of five fingered flippers. It is interesting to note that these sea serpents died out about the same time that the living coelacanth was previously thought to have become extinct, so that it is hard to deny completely their possible existence in the sea today.

For over 100 million years the reptiles peopled the seas, and during much of this time they were the dominant creatures of the ocean, helping to exterminate many of their predecessors and finding no serious

THESE *enormous skeletons of an ancient mosasaur and plesiosaur, the ancient sea reptiles, are shown along with Philip Reinheimer (left) and Robert Landdberg.*

competition from the fishes. But suddenly the reptiles both on land and in the sea suffered a dramatic decline which resulted in the complete extinction of most of them. The cause for this is unknown. It may have been because of great climatic changes, and a cooling of the land and of the seas to which larger reptiles could not accommodate. But if a few scattered individuals had been able to survive to the present day they could well provide experiences at sea beyond even the imaginative tales of the early writers. With few exceptions, no sea creatures have been produced since their time which are more aggressive and more monstrous.

In the last geologic era the fishes gradually took command in the sea, but at the same time the mammals, no longer dominated by reptiles, were developing fast on land. Some of these have returned again to the sea by the evolution of whales, porpoises, sea cows, sea lions, and seals. One of the early whales has especial interest in connection with sea serpent stories, since it has been held up as a possible source of these tales. In the late Eocene, about 50,000,000 years ago, there appeared in the seas of North America, Egypt and Europe a group of whale-like creatures, the zeuglodons. One of these, *Basilosaurus*, could well have inspired the sea serpent story if it lived today. Unlike modern whales, *Basilosaurus* was slim and almost serpent-like in appearance. Its head was comparatively small, only 4 feet long, and its body 10 feet long, but the tail was 40 feet in length. Moreover, the last time at which *Basilosaurus* is known to exist, from fossil evidence, is much later than that of the fossil coelacanths, which exist today. But until it has been definitely seen it is at least equally probable that it died out in the days of the Eocene. At this time the great shark *Carcharodon* was living, with jaws that gaped 6 feet across, and it may very well have taken a part in exterminating *Basilosaurus*.

So, during the long period of nearly a billion years during which life has existed on earth, a procession of varied forms has continuously evolved. Many of them have been monstrous in size, some in the strangeness of their shape. Some, like the *Basilosaurus* or the mosasauris, bear a resemblance to the fabled sea serpents. Others, like ammonites, the giant sea scorpions, and the primitive fishes are like nothing met with even in fable. Purely from the point of view of the fossil record there can be no complete denial of the suggestions that at least some of these, particularly in cases for which fossil records were left as recently as 100 million years ago, might still be alive in the ocean today.

For Further Reading:

Historical Geology, by Carl O. Dunbar. John Wiley & Sons, 1949. This is a textbook of geology for students rather than the general reader, but the sections on extinct animals are well illustrated and readable. There is no good popular work on extinct marine animals.

Historical Geology, by Russell C. Hussey. McGraw Hill, 1947. Marine animals now extinct are considered in this book only as part of the geological history of North America.

The Lungfish, the Dodo and the Unicorn, by Willy Ley. Viking Press, 1948. For the general reader. Not mainly concerned with sea monsters but mentions the coelacanth.

Dragons in Amber, by Willy Ley. Viking Press, 1951. Well written for the general reader. Not primarily about extinct marine monsters but has a section on ichthyosaurs.

Record of the Rocks, by Horace G. Richards. The Ronald Press Company, 1953. A geological story of Eastern North America.

The Search Beneath the Sea, by J. L. B. Smith. Henry Holt and Company, 1956. An account of the discovery of the coelacanth. See review elsewhere in this Bulletin. Just off the press.

Darwin Anniversary Voyage

PLANS are being discussed for a scientific expedition which will commemorate Charles Darwin, the famous author of theories of evolution.

The committee set up for this purpose plans, among other activities, to arrange for a scientific cruise which will retrace the voyage of the *Beagle,* in which Darwin made many important observations. The new *Beagle* is to set out in 1958, on the 125th anniversary of the original voyage, which is described in our Bulletin Vol. 1, No. 2, of May 1955.

It is hoped that Darwin fellowships will become available for scientists who wish to take part in the work of the expedition. More detailed information will be published in future issues of this magazine.

Queer Fish

A GIGANTIC *Mola mola,* commonly known in this country as a sunfish, is reported by Arturo E. Llavallol, member of the Game Fish Committee of the International Oceanographic Foundation at Buenos Aires. The big fish, which was stranded at low tide on a beach near Comodoro Rivadavia, Territory of Chubut, Argentina, weighed 1,200 kilos or 2,640 lbs.

In Argentina the *Mola mola* is commonly called a moonfish, and the one reported by Llavallol is the largest ever recorded there. "Occasionally they appear in our waters and there is a plaster cast of one of the largest found up to now in the Museum of Natural History of Buenos Aires," Llavallol reports. "It was caught 10 miles offshore Mar del Plata and weighed 530 kilos, clean."

Mola mola is a slow-moving fish, oddly shaped and usually found on the surface of the sea. Its favorite food is jellyfish. Although slow of movement ordinarily, it can be quite active and can leap completely out of the water despite its peculiar shape and huge size.

Strange Fishhook—Strange Fish

Giant sunfish are occasionally found off Florida and the Bahamas. Some years ago one of them, weighing nearly a ton, was found impaled on the anchor flukes when the Imperial Lighthouse Service tender, *Firebird,* weighed anchor in these islands.

Two other close relatives of the *Mola mola* are the *Masturus lancelatus* and *Ranzania truncata,* the first very seldom encountered and the second of small size, that probably never exceeds two feet in length.

GIANT SUNFISH *reported from Argentina by I.O.F. member Arturo Llavallol.*

Biological Oceanography In British Columbia

By ROBERT F. SCAGEL
Institute of Oceanography, University of British Columbia

THE VARIOUS ASPECTS of biological oceanography are intimately bound up with oceanography in general. Investigations are becoming more diversified than they have ever been in the past and a greater degree of integration is becoming apparent in an attempt to coordinate knowledge from the various branches of biology, as well as science in general, in an understanding of the sea. On the coast of British Columbia, Canada, a number of different groups are actively engaged in and promoting research in this very important field. The Institute of Oceanography was established at the University of British Columbia in 1949 and is a part of the Faculty of Graduate Studies. In addition it receives support from the Defense Research Board and from the Canadian Joint Committee on Oceanography representing the Royal Canadian Navy, the National Research Council, the Fisheries Research Board, and the Hydrographic Service. The Institute represents the cooperative efforts of the departments of Biology and Botany, Chemistry, Geology, Physics, and Zoology to provide students with the fundamental knowledge which these branches contribute to an understanding of the ocean and with training in the techniques of oceanographic research. A number of research projects are being pursued.

The coast of British Columbia presents a challenging variety of problems for the oceanographer whether as chemist, geologist, or physicist. But to the biologist it is a particularly interesting area presenting a wide variety of habitats in which to study marine life.

As the crow flies, the coast of British Columbia is about 600 miles long but when all its various ramifications are included there is a coastline estimated at about 25,000 miles in length.

The tidal amplitude is great in this region, ranging from about 11 feet at the southern boundary to nearly 26 feet at the northern boundary. Thus there is an extensive vertical intertidal zone in which to study the distribution of marine organisms at first hand.

The geological nature of the coastline presents a variety of substrata ranging from predominantly solid rocky shores through pebble, gravel and sandy beaches to mud flats. Although the latter are less common, it is possible in certain areas to study the effect of substratum on the distribution of marine organisms under rather similar oceanographic conditions.

The Migrating Salmon

But the most outstanding oceanographic feature of the coast is the variety of salinity conditions found there. The mainland is furrowed by many long and deep inlets surrounded by high mountains whose peaks are snow- or ice-covered throughout the year and whose glaciers provide extensive runoff. There are many large rivers entering the sea. The most notable are the Fraser and Skeena Rivers, both of which are linked, through migration of the Pacific salmons, intimately to the sea and the economy of the Province of British Columbia.

Because of the migration pattern of these salmon, which spend part of their lives in fresh-water and part in the sea, many fisheries' problems related to the salmon fishery, as well as to strictly oceanic fisheries, are essentially oceanographic problems. The problem of predicting the salmon migration at sea is of particular importance locally as well as internationally and requires a detailed study of the oceanography in the North Pacific before the fishery can

THE RISE OVER FALL OF TIDE *in British Columbia is considerable. As a result, great areas of rocks and pools are exposed at low tide in which biologists may study distribution of plants and animals. In gullies such as this, the vertical walls between tide marks provide an interesting study of the vertical distribution of marine life and the reasons which cause different species to live at different levels.*

MARINE BIOLOGY *in British Columbia is not confined to the direct observation of living marine life. The chemical and physical nature of the water in which it lives is important so that the facilities of a research vessel are necessary.*

be adequately protected, administered and exploited.

Salinities range from practically fresh-water at one extreme near the mouths of rivers and at the heads of deep and narrow inlets to full ocean salinities of about 33 parts per thousand along the outer coast at the other extreme.

A combination of large tides, dilution effects, winds and the many narrow passages weaving among countless islands scattered along the coast provides a complicated system of currents, in some instances reaching a speed of about 14 knots. The result is that, except for confined embayments, the area is generally one of well-mixed water and relatively uniform temperatures prevail near the surface. The annual range in temperature of the surface waters is from about 6 degrees C. to 18 degrees C.

Muddy Waters

The excessive inflow of fresh-water carries a large amount of sediment and suspended material into the sea. This particulate material, combined with the mixing effect resulting from currents and upwelling, make the

waters along the coast relatively turbid. As a result the illuminated zone is somewhat restricted and, in contrast to the clearer water of tropical regions, there is little photosynthetic activity below a depth of about 25 meters.

Proceeding offshore in the summer the colder waters (about 12 degrees C.) associated with the coast disappear and warmer areas of water reaching a temperature of about 18 degrees C. are encountered in the oceanic area about 30 to 50 miles off the coast. This warmer water occurs close to the coast at this season of the year largely as a result of the prevailing westerly winds. At times during this period the albacore tuna *(Thunnus alalunga)* can be caught offshore in this warmer water. However, in the fall and winter, when the prevailing winds come from the southeast, this warm water disappears and with it apparently go the albacore.

To the biological oceanographer interested in studying native populations there is an abundant and varied flora and fauna both in the bottom-dwelling forms as well as in the free-swimming and plankton forms. The extensive intertidal zone makes the study of bottom-dwelling forms particularly instructive.

Seagoing Botany

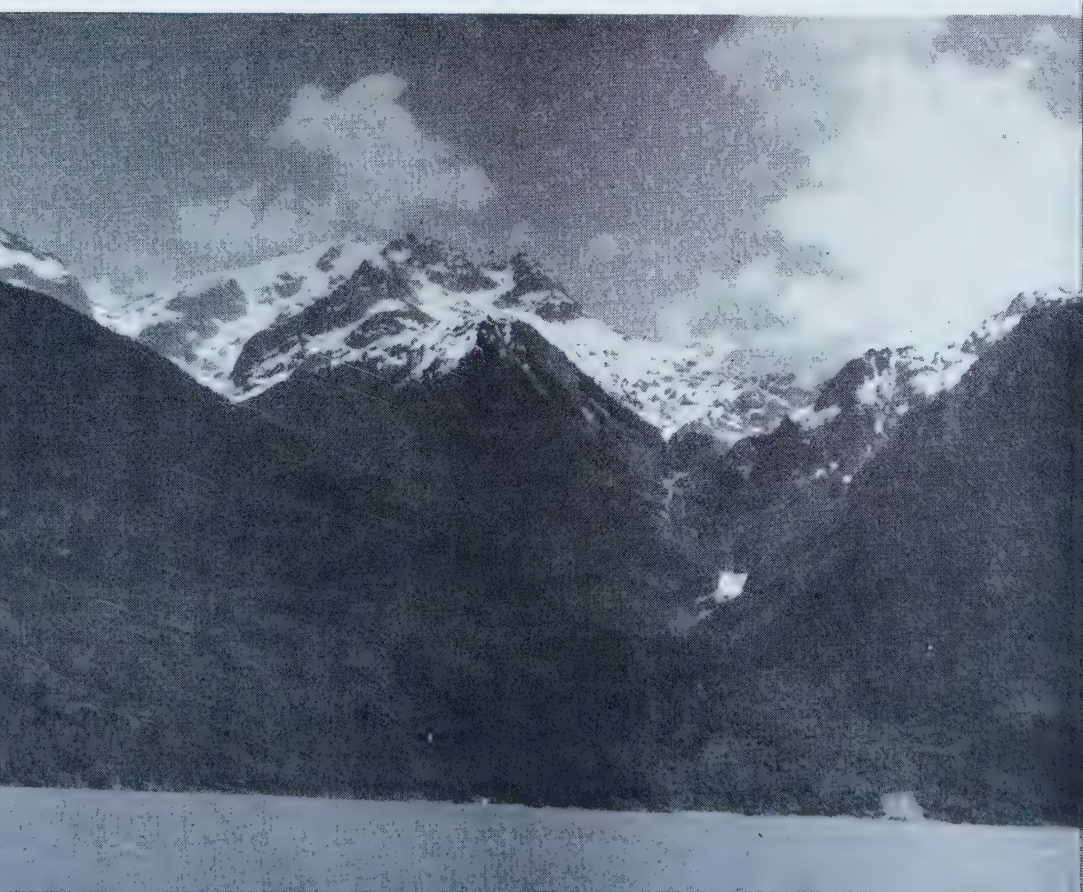
For the botanist interested in the larger marine plants such as seaweeds and marine grasses there is a spectac-

THE COAST OF BRITISH COLUMBIA *is protected by countless scattered islands among which narrow passages twist and turn.*

ular flora. The algal flora is probably unsurpassed in any other part of the continent and perhaps equalled only in colder latitudes of the southern hemisphere. The giant seaweeds or kelps, *Macrocystis* and *Nereocystis,* are present in extensive beds covering many square miles along the coast. These larger forms comprise only a part of the predominant and varied brown algal flora which ranges from small, almost microscopic plants, such as *Pylaiella,* to the curious open coast seapalm *(Postelsia palmaeformis),* which grows only on rocky ledges exposed to the heaviest surf. Scattered through the intertidal zone among bright green algae, but reaching their predominance in the subtidal zone, are the brilliant and beautiful red algae. Although few in numbers of species, marine grasses are found in abundance. In the inner waters and in sheltered bays extensive beds of eel-grass (*Zostera marina)* occur and on the open coast the bright green basket-grass *(Phyllospadix)* covers the rocks in the lower intertidal zone.

For the zoologist interested in the sessile invertebrates there are many varied and bizarre forms to study.

MANY LONG AND DEEP INLETS *cut into the coast and act as reservoirs for the extensive run-off of fresh water from the glaciers on nearby snow- and ice-capped mountains.*



ONE OF THE STRIKING *features of this coast is the large seaweed or kelp,* Nereocystis, *known as the sea onion. In many places it forms dense beds extending over several square miles. Another kelp,* Macrocystis, *is one of the largest marine plants known and grows to be hundreds of feet in length.*

Curious outer coast animals such as the stalked barnacle *(Mitella polymerus)*, the open coast purple urchin (*Strongylocentrotus purpuratus*) and the vivid purple hydrocoral *(Allopora porphyra)*, the stalked jellyfish *(Haliclystus sanjuanensis)*, the cosmopolitan green urchin (*Strongylocentrotus drobachiensis)*, and in the deeper water colonies of brachipods *(Tetrabratalia transversa*) and crinoids *(Florometra serratissima)* are found.

Many of the algal and invertebrate groups are little-known and await the patient study of the taxonomist before they can be used to their full extent by the biological oceanographer.

Oysters and Pests

To the biologist interested in ecology and exotic introductions there are noteworthy examples for study among both plants and animals. The Japanese oyster (*Crassostrea gigas*) was introduced commercially to the coast and with it have unintentionally come a large brown alga, *Sargassum muticum,* and a Japanese oyster drill, *Pseudostylochus ostreophagus.* Both have become widespread. *Sargassum* has spread in increasing abundance into extensive beds, chiefly in the

THE STALKED BARNACLE, Mitella polymerus, *lives on the coast of British Columbia in areas having high salinity. It is able to withstand the heaviest surf which pounds the rocks of the open coast.*

vicinity of oyster farms, and seems to be replacing the eel-grass *(Zostera marina)* to some extent in warmer bays in Southern British Columbia. The drill has become an abundant and injurious pest causing losses to the oyster industry.

The plankton is somewhat less unique regionally, but an extensive flora and fauna exist, again reflecting the variety of oceanographic conditions prevailing. At times extensive blooms or concentrations of diatoms occur. Although individually these amazing one-celled photosynthetic plants are microscopic, they play an extremely important role in the economy of the sea. Diatom blooms are frequently followed by concentrations of dinoflagellates and in turn by microscopic animals or zooplankton which graze upon the primary producers and eventually form the basis for sustenance of all the larger forms of life in the sea.

Diatoms, dinoflagellates, arrow worms, copepods, ctenophores, jellyfish, tunicates, worms, their larval forms and reproductive stages or larval forms of the bottom-dwelling flora and fauna are abundant in the area. These provide the biological oceanographer with a wealth of marine life to study and apply to an understanding of the sea and life processes which are so intimately a part of the marine environment.

Science of the Sea in Books

J. L. B. Smith, author of The Sea Fishes of Southern Africa, has received a few weeks ago the medal of the Royal Geographical Society. December 1949. The book was published by Henry Holt and Company on October 24, 1949.

THE 70 FOOT MOTOR TRAWLER Monte Carlo, *designed by M. Rosenblatt & Son of New York and the author, the first American fishing vessel fitted with the highly maneuverable controllable pitch propeller and bridge controls.*

Ocean Resources

By FRANCIS MINOT, *Director*
Ocean Resources Institute, Inc.

WOODS HOLE has a long and honorable record in marine research and its several organizations have made notable contributions to the science of the sea. As far back as 1873 Louis Agassiz established his natural history laboratory on nearby Penikese Island in Buzzards Bay. He was only the first of a long line of distinguished scientists who have made biological and oceanographic history in the Woods Hole area.

Fishery Station

In 1875 the United States Fish Commission (now the Fish and Wild-

life Service of the Department of the Interior) established a station in Woods Hole to promote the interests of the commercial fisheries. The building of its laboratory followed in 1885.

These beginnings were followed in 1888 by the founding of the Marine Biological Laboratory, a private nonprofit organization, which now provides research facilities for about 400 investigators and summer courses of study in vertebrate zoology, embryology, physiology, marine botany and marine ecology. While its principal activities are carried on during the summer months when many teachers and students make use of its facilities, its superb library of marine science and biology is open throughout the year for reference and study.

Oceanographic Research

In 1929 the Woods Hole Oceanographic Institution was founded through the efforts of the National Science Foundation. This laboratory has become a leader in oceanographic research and has particularly extended our knowledge of the Atlantic Ocean. In addition to its wide ranging investigations, it has done notable work in physical oceanography for the U.S. Navy. It operates on a year-round basis and maintains a staff of some 300 persons.

All of these laboratories enjoy the advantages which the geographical location of Woods Hole affords—the many bays and sounds, the varied coast line of Cape Cod and the adjacent islands, nearness to the open ocean, the warm Gulf Stream and the cold Labrador Current. From such a choice location these laboratories send to sea their deepwater research vessels and small craft.

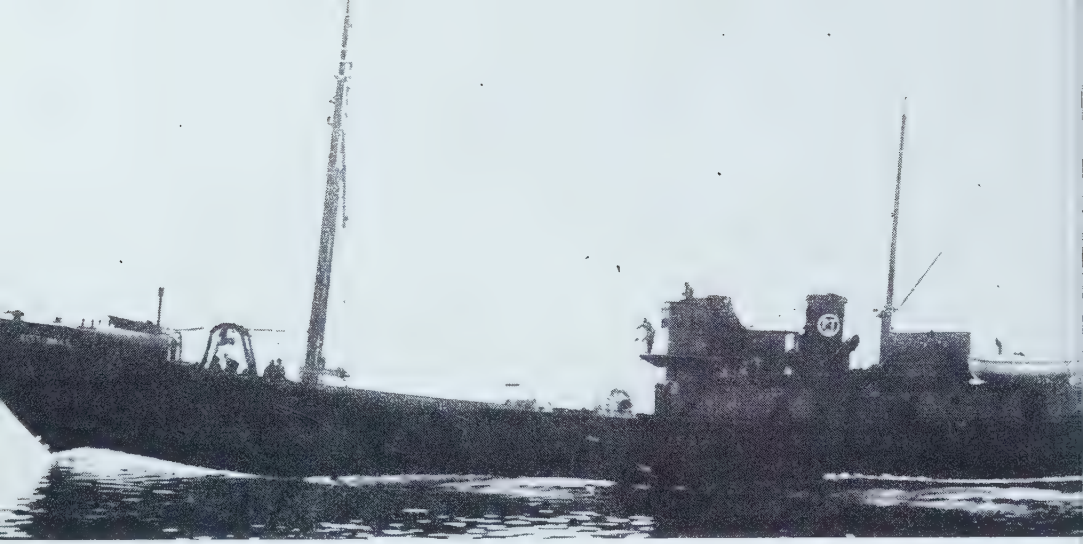
Wartime Stimulus

The global problems of the Second World War fostered more intensive oceanographic investigation and stimulated the use of more marine resources. Problems of storms and waves needed solution for the advantageous operation of landing craft on enemy coasts. Submarine warfare called for the understanding of underwater acoustics and the development of effective instruments. The threat of attack from aircraft and submarine required new standards of safety for troop and supply ships. The techniques of air-sea rescue were evolved. Demands for food promoted greater fishing effort in many places. Magnesium was recovered from sea water in commercial quantities. Many wartime developments proved of lasting value.

In 1951 Ocean Resources Institute, then called Marine and Fisheries Engineering Research Institute, was founded with an initial grant from the Friendship Fund of New York City, a philanthropic trust established by the late Charles R. Crane and administered by his heirs. The founding of the Ocean Resources Institute came about in this way.

Designing Research Vessels

I had been keenly interested in the marine institutions in Woods Hole since boyhood and had had professional relations with the Woods Hole Oceanographic Institution commenc-



ATLANTIC COAST FISHERIES COMPANY *motor trawler* Kittiwake, *designed by the author's firm in 1937.*

ing with the design and building of its research vessel *Atlantis* in 1930. Other research vessel problems had followed. Shortly after the end of the war I had returned to Cape Cod and renewed my relations with the Woods Hole Oceanographic Institution and had many long discussions about the exploration and exploitation of the ocean with its director, Dr. C. O'D Iselin with whom I had been closely associated during the building of *Atlantis*. The wide gap between marine science and industry became increasingly clear as various possibilities for the utilization of the ocean's resources were considered. This gap was evidenced most strikingly by the great need of the ocean fisheries for scientific information and technical guidance. Out of these many discussions came the concept of a marine resources institution similar in kind, but somewhat different in purpose, to the existing scientific laboratories. Our reasoning was something like this.

Over the past fifty years technology has profoundly revolutionized the way of life in the western world, and is now reaching out into the less "advanced" regions and those where simple agriculture is the predominant occupation. Through such progress, man is rapidly acquiring some control over much of the usable and livable land masses and he now makes important use of the air. Relatively, he has made little inroad into the sea for purposes other than transportation and the hunting of fish; as yet the technological revolution has not been greatly extended to that larger part of the world's surface which is covered by salt water.

Neglect of the Sea

At first glance, this would appear to be an astonishing anomaly in light of man's extra-ordinary technical prowess. But there seem to be many and diverse causes for man's relative neglect of the sea as a source of use-

ful things: an age old fear of its enormity and mystery, the great difficulty of farming it or mining it as compared with the ease of so doing on land, the unique state of non-ownership of the open ocean.

The fact still remains that anything approaching intensive exploitation of the sea still awaits that degree of adventure and reward, and that combination of determination, ingenuity and deliberate action which have aroused and enabled man to conquer the land and to evolve our urban industrial society. The sea is all around us—over 100 million square miles in area and nearly 3 miles in average depth. In recent years man has slowly come to recognize it as an incredibly vast and, in a certain sense, an inexhaustible reservoir of food and raw materials.

A New Institute

Ocean Resources Institute has much less specialized interest in the ocean than that of the laboratories of marine science. It is concerned with the potential value of the ocean's resources and properties in the national and world economy. It is concerned with the social and political effects of making greater use of the ocean. It hopes to broaden the public interest in the ocean. It aims to give practical expression to some of the mounting store of knowledge which is being accumulated by the oceanography sciences, to evaluate this knowledge in terms of human welfare and to share in the evolution of an "ocean" engineering, the engineering of man's efforts to gain some control over the world-wide liquid environment of the sea.

It is our viewpoint that the effective utilization of the ocean's resources and properties can be accomplished only by taking consideration of the ocean in its entirety and from many points of view. By this, we mean that science, engineering, economics and the social sciences must join in an approach to the ocean from a point of view which is global and international.

Future Role of the Sea

The rapid increase in world population and the demand for raw materials and energy are indicators that man may have to find more and more of his material requirements in the sea. The ocean has certain fundamental attributes which make it rich in potential resources which are so striking and unique as to warrant thoughtful attention. These are the attributes, we think, which justify belief that the ocean can and will play a much more important part in man's future than it has in his past.

1. Its vastness—70 per cent of the world's surface and some 300 million cubic miles in volume—all as yet only partially understood.
2. Its global influence on weather.
3. Its unrivalled virtue as an international highway for bulk transportation.
4. Its food resources, as yet unmeasured—neither present day science nor commercial fishing is able to establish realistic limits of productivity.

5. Its latent energy and mineral resources, development of which must await a real technology of the sea.
6. Its freedom from nationality—half the world is "high seas," as yet politically free to all.

Let us consider these broad aspects of the sea for a moment. . .

Universal Reservoir

It is not size alone which makes the vastness of the ocean so impressive and so meaningful as its global extent and the fact that the oceans and seas and their tributaries are really one. Every point on every ocean, sea, and tidal river can be reached from every other point. The ocean is water, that amazing liquid substance filled with life and through which living things and man-made things can freely move. As the world's reservoir of water, the ocean is an important part of the global heat engine and a determinant of climate and weather. It is rich in mineral content which has washed from the land since the beginning of time. Its production of vegetable and animal life is enormous. Its many forms of energy are easy to see in wind, wave and sunlight.

Together with these many significant material attributes, the open ocean is unique in that it belongs to no nation nor is its possession as yet seriously claimed or disputed. This is in contrast to the lands and now much of the air above them, all of which are possessed by some sovereign nation with the sole exception of the Antarctic Continent. Perhaps the most significant feature of the ocean is its non-ownership and the opportunities which it offers for peaceful exploitation.

The Economic Viewpoint

Ocean Resources Institute is working to provide an adequate laboratory and a responsible voice for the ocean as a source of useful things and as a realm for further development. It is trying to initiate an agressive approach to the ocean in its entirety and to develop an effort which will become comparable to that accorded to agriculture and other world-wide activities. It recognizes that problems of development and utilization must be looked at from the economic and social point of view quite as thoroughly as from those of science and engineering and it hopes to interest professionals in many fields in these questions. It plans to become a center of study and discussion where many points of view will find expression.

The objectives of Ocean Resources Institute are twofold: the exploration of the long-range potentialities of the ocean and its resources, and characteristics; and the investigation of specific oceanic problems which require specialized engineering and the development of superior or novel tools and techniques.

The five years which have passed since the founding of this Institute have been admittedly a formative period. We have spent much time and thought in formulating what seems to us a most useful role in the marine world, one which combines engineering and economics in a broad sense and promotes oceanographic re-

search and development of marine resources. We have gradually evolved a sort of philosophy toward the ocean as a realm of human interest and activity which gives meaning to our purposes and definition to the kind of program which we are now in the process of composing. The composition of such a program also requires much time and thought for if it is to be significant it must stand on a broad base, it must have long term implications of merit and while recognizing clearly all of the significant aspects of the ocean it must restrict the direct efforts of this Institute to those aspects in which we have experience and competence.

LAUNCH RISK, *ready for inclining experiment recorded photographically to determine stability with extreme accuracy, in preparation for wave and ship motion tests.*

Growing Interest

Much of our time has been spent in describing the role which we envision to those groups which can support our endeavor and those which can likewise benefit from its success. Thus we have become acquainted with many philanthropic foundations and with many large industrial companies. It is gratifying to find that interest in the ocean and recognition of the importance of its resources is growing steadily. We feel sure that this interest will continue to grow.

In addition to what might be called development and promotional work, we have accomplished a number of useful tasks and considered several

profoundly interesting problems.

We have made a number of fisheries studies which indicate several directions of investigation, which should be pursued if fish production is to be materially increased. We made a rather extensive study of the requirements and desirable features of ships for oceanographic research and, in collaboration with the Woods Hole Oceanographic Institution, submitted this study to the Office of Naval Research with encouraging results. We participated actively in the first International Fishing Boat Conference which was held in Paris and Miami in 1953 under the sponsorship of the FAO and have membership in its permanent Western Hemisphere Committee. We have kept closely informed of the fine work which the Fisheries Division of the FAO is doing, through its fisheries assistance program in many backward and needy areas.

Mine Hunting Craft

We developed the preliminary design of a novel mine hunting craft for a study of mine countermeasures which Yale University made for the Office of Naval Research. We prepared a report on the ultimate fate of merchant ships for the Mine Advisory Committee of the Office of Naval Research. We collaborated with the Woods Hole Oceanographic Institution and New York University in some initial wave form and ship motion investigations for the Office of Naval Research and the David Taylor Model Basin and are much interested in various seaworthiness studies which have developed from this early work. Such studies are now sponsored by the Society of Naval Architects and Marine Engineers, the Experimental Towing Tank of Stevens Institution of Technology, Massachusetts Institute of Technology and elsewhere. The recent collision of the passenger liners *Andrea Doria* and *Stockholm* has raised technical and operational questions into which we are inquiring.

We are planning to sponsor with the Woodrow Wilson School of International and Foreign Affairs at Princeton University a small marine resources conference in early 1957. The purpose of this conference is to pose problems of ocean exploration and ocean resources to a diversified group composed of economists, social scientists, lawyers, and others—and to arouse their interest in the sea and its possibilities for utilization. We hope that this initial meeting will be the forerunner of further conferences of similar nature.

Looking to the Future

We have somewhat diversified talent among those who are most closely associated with our work. Dr. Columbus O'D Iselin and Allyn C. Vine are on the staff of the Woods Hole Oceanographic Institution; Prof. Herbert L. Seward, our President, is professor emeritus at the Yale School of Engineering and a distinguished consulting marine engineer; Dr. Harden F. Taylor was for many years the President of the Atlantic Coast Fisheries Company and later research professor at the School of Fisheries at

the University of North Carolina and a past President of the New York Academy of Sciences; Mr. Francis W. Sargent is the Director of the Division of Marine Fisheries in the Department of Natural Resources of the Commonwealth of Massachusetts.

The events of the past five years encourage us to believe that Ocean Resources Institute will be able to contribute to the progress of marine development.

Turtle Headed Seal

AN ANIMAL that can pull its head almost completely into its neck has just been added to the collections of the Smithsonian Institution. This would not be unusual if it were a turtle. But it has been added, not to the reptile collections, but the mammals.

This mammal with turtle-like neck is the Ross seal, rarest of all the seal family in the Antarctic. It was collected by the Navy's polar expedition last winter, and the frozen specimen recently arrived at the U.S. National Museum in Washington in excellent condition.

This seal—about eight feet long—is a dweller exclusively on the drifting ice pack of the Ross Sea. So far as known it never comes on land or on the ice shelf. It apparently feeds almost exclusively on cuttlefish and squid, which are abundant in Antarctic waters. The nature of its teeth precludes the likelihood that it is a fish-eater.

It is yellowish-green on the underside and blackish-brown on the top, the fur often being marked with pale streaks along the sides. On the drifting pack it has fearsome enemies—notably the killer whale and the writhing, snakelike sea-leopard, most savage of the seal family. This may account for the relative scarcity.

The outstanding peculiarity of the creature, probably unique among mammals, is the thick bloated neck into which the head can be withdrawn. This may be a protective development, although it hardly could serve the creature against the two above-mentioned enemies. On the other hand, withdrawal of the head may be a comfortable habit in a very cold climate.

Nassau Game Fish Conference

THE FIRST CONFERENCE to be sponsored by the Foundation will take place on Tuesday, November 27, at the well known British Colonial Hotel in Nassau, Bahamas.

Among the participants will be big game anglers from several countries, well known fishing guides and marine biologists from Bermuda, Yale University, Woods Hole Oceanographic Institute and the game fish research team of The Marine Laboratory, University of Miami.

Anglers and Scientists Meet on Game Fish Problems

The program will include a round-table discussion of ways and means for closer cooperation between scientists and anglers in the interests of increased knowledge of the migrations, life histories and feeding habits of salt-water game fish. A discussion panel of experts, which will be open to questions from those present, will include Dr. James E. Morrow of the Bingham Oceanographic Laboratory of Yale University, Dr. Gilbert Voss, head of the game fish research team at Miami, and Dr. Richard Robins, ichthyologist from Miami. Among other Foundation members on the panel will be Frank J. Mather, of the Woods Hole Oceanographic Institute, now working in the Virgin Islands, and Mr. John Manning, who has just returned from three years of work as a field associate of the Miami laboratory in Chile, Ecuador and Peru. Colonel John K. Howard, whose work in recent years on the marlins and sailfishes has taken him to East Africa and New Zealand, will also participate. Al Pflueger, who in his work of mounting fish specimens from all parts of the world has probably had more opportunity of observing game fish than almost anyone else, is also an active member of the Foundation and will take part in the discussions.

The conference will be under the chairmanship of Mr. Charles F. Johnson, president of the Foundation, and well known big game angler.

Among a number of scientific reports which will be submitted and explained to the nonscientific participants will be the interesting findings of Dr. Morrow on the important differences in the bone structure of the marlin pectoral girdles. This is important in view of the controversial question of the true nature of the fin differences in marlins which have been used in telling them apart by anglers and others. Dr. Voss will report on marlins and sailfishes, but from the point of view of life histories. With his staff of ichthyologists Dr. Voss has carried out a considerable amount of work on the life

FISHING IN BAHAMIAN WATERS *will be an added attraction to those attending the meeting in November. Angling with light tackle in shallow water is especially good for bonefish and barracuda. Don McCarthy, I.O.F. member, gaffs 15 pound barracuda at Walker's Cay.*

histories of marine fishes and has so far sorted out of his collections the amazing total of 13,000 different specimens of the most important fishes.

Frank Mather will report on the Virgin Islands fishes, while Louis Mowbray, director of the Bermuda Aquarium, will discuss the game fishes of Bermuda. Ocean-going game fishes of Chile and the bluefin tunas will also be reported upon by Miami scientists.

Those interested in saltwater game fishing are cordially invited to attend and participate. Programs, hotel reservation and registration blanks will be promptly mailed in response to enquiries addressed to the offices of the Foundation. Arrangements for local fishing boats and guides in Nassau will be made upon request.

Commercial Fishery Meeting

The Gulf and Caribbean Fisheries Institute has arranged a week long conference in Nassau, beginning Monday, November 26, as part of which the Foundation will sponsor its Game Fish Conference. The remainder of the week will be devoted to problems of commercial fisheries. The program will include leading fishery scientists, marketing specialists, experts in fish processing and the leaders of the fishing industry from all parts of the United States and from several countries.

The Gulf and Caribbean Fisheries Institute was founded nine years ago and has met annually in Miami and Havana. This year it has arranged for concurrent meetings of the Shrimp Association of the Americas, the Southeastern Fisheries Association and the Atlantic States Marine Fisheries Commission.

Territorial Waters Controversy

Because of the importance of the shrimp industry, one whole day will be given to the legal, biological and technological aspects. An analysis will be given by a well known international law expert, on the latest developments in the problem of territorial waters and how they affect fisheries. Successful methods of controlling black spot in shrimp and mesh size experiments will be described by Miami scientists. A summary of progress in shrimp studies and details of rigging vessels for deepwater red shrimp will be described by the U.S. Fish and Wildlife Service.

Spearfishing Control

Besides shrimp papers many other topics of interest will be discussed. These include summaries of menhaden research, life history studies on croakers, spotted trout (weakfish) and reef fish and an outline of the problem of spearfishing. In the Economic Session a study of the probable future trends in fish consumption in the United States will be presented.

The Cuban fishing industry will be described, and the fishery programs of the Food and Agriculture Organization in Latin America will be outlined. The meeting is open to all interested on application to the Executive Secretary, Gulf and Caribbean Fisheries Institute, University of Miami, 439 Anastasia Ave., Coral Gables, Fla.

Ocean Birds

By HILARY B. MOORE

The Marine Laboratory, University of Miami

WHEN THE FIRST amphibians, ancestors of our frogs and newts, crawled onto dry land they were opening up a vast new territory for their exploitation. They were also escaping for a time from their less gifted aquatic enemies, although fresh ones were soon to evolve on land also. The air was another new world, ripe for exploitation, when the first reptile learned to fly, although it could never be more than a temporary home since the flying animals which use it have to return to land or water sometimes.

Return to the Sea

Despite the great migrations from water to land and from land to air, there have always been some animals which stayed in the old habitat or returned to it. The forelimbs of whales, descendants of land mammals, have evolved into flippers and these lung breathers have gone back to the sea from which their distant ancestors arose. Some birds, such as the ostrich, have gone back to the land and lost their powers of flight. Others, like the penguin, have taken to the water just as efficiently as the whale, although they still come to land to nest. Their wings, though, are used as paddles and are quite incapable of flight. There are other birds, however, which have taken the ocean as their home and yet retained powers of flight that are unsurpassed among what we know as land birds. Living most of their lives far out on the ocean, they are quite unknown to most landsmen, although a familiar enough object to the mariner. Only after some great storm are they reported as rare strangers in inland regions.

Tubelike Nostrils

Nearly all these ocean birds belong to a very ancient order, the Procellariidae, one of whose most striking characteristics is the queer, tubelike nostrils on top of the beaks. The scientist, as usual, has produced such tongue-twisting names for them as *Halocyptena, Phoebetria* and *Bulweria.* The antarctic whalers, to whom they were a familiar sight, gave them more attractive names. The Albatross, greatest of them all, with a wing span up to nearly twelve feet, was originally known as "Alcatraz" which is the Spanish name for the pelican, a fine fisherman but far different on the wing. The Shearwaters, skimming just above the waves, are obviously well named. Their relatives, the Storm Petrel, flitting over the water with their feet just treading the surface may have been named for St. Peter, who walked on the water. The "Mother Carey's Chickens" probably take their name from a corruption of "Mater Cara," the Blessed Virgin

OCEANIC BIRDS. *The lines draw attention to points useful in quick identification.*

Mary. Less piously named are "Mutton Birds" and "Hags" and the Molly Mawk, whose original Dutch name meant "foolish gull."

Accomplished Gliders

Long sustained flight is essential to them and we find it developed to a pitch unsurpassed among land birds. While some of them fly mainly by flapping their wings, many, and in particular the albatrosses, are gliders so perfectly built that they can follow a ship for hours with hardly a wing beat. Flying low over the waves they can take advantage of local updrafts, which scientists are only now learning to understand. In fact, it was from watching sea-birds on the wing that Alfred Woodcock of the Woods Hole Oceanographic Institution learned the pattern of these wind-cells. These gliders settle on the water to feed, but the little storm petrels, more fluttering in their flight, patter along the water with their feet as they let their outstretched wings carry most of their weight.

All of them feed on what they can find on the surface of the sea. They can dip below the surface in pursuit of it, but have never acquired the swimming powers of the penguins or auks. Their food may be live plankton, squid and such, taken mostly as it comes to the surface at night, or it may be such dead bodies as they are lucky enough to encounter. When whales are killed or fish trawls hauled aboard, enormous numbers of birds gather round to snare the kill, and it has even been suggested that the great increase in numbers of Fulmar in the last two centuries has resulted from the increased food supply as whaling and trawling increased in the North Atlantic.

The only real tie which these birds have with the land is their need to come ashore to nest. To quote Wynne Edwards:

"For many of these birds the high sea is their element; and when, as they must, they forsake it to breed, they resort by night to the outermost stacks and loneliest islands as if they grudged even this last contact with the shore."

Using their legs so little, most of them are amazingly clumsy on land, and some cannot even stand at all. This leaves them particularly vulnerable to attack, and we find most of them seeking safety for their nests in burrows and clefts in the rock. Only the biggest of them are safe to nest out in the open. The egg is white and lacks the camouflage pattern of most birds. Only one is laid each year so there is no surplus stock to take care of loss to predators. It is incubated unusually long — sixty days in the Black-browed Albatross, compared with only twenty-eight in the large Glaucus Gull. The parents take turns at the nest, often for spells of several days, while the other is away on the feeding ground. When the young are grown they do not have the opportunity for practice flights, as do land birds. They may have to climb out of their burrows, launch their first flight from a close by hillside, and fly even several miles to the nearest water on which they can rest.

Nesting Areas

In preparation for this the parents must bring the steady flow of food that nestlings need, and the supply of food has an important bearing on the selection of nesting sites. Leach's Petrel, for example, nests only along the coast of northeastern North America, southern Greenland and Iceland and on islands along the northwest of Scotland. This is along a plankton-rich band which stretches across the North Atlantic. Other species are concentrated in antarctic regions where they can feed on the rich plankton which attracts also such great concentration of whales.

Once the young birds leave their nests, they will have no need for land again until they are old enough to breed, several years later. They are free to follow their food supply on the wide stretches of ocean. The supply of food in the surface waters is either plankton itself or higher forms which feed on plankton. Polar seas produce enormous plankton crops but these are seasonal and most of the whales and birds that feed there must move away for the winter. Although a more coastal bird, the Arctic Tern, holds the long distance record for seasonal migration, many of the oceanic birds travel very great distances.

Skilled Navigators

The Greater Shearwater, for instance, breeds during the southern summer on the island of Tristan da Cunha, thirty-two degrees south of the Equator. In our spring they are moving north, appearing off the West Indies in March and off Cape Cod in May. They spread up as far as Davis Strait and across to Greenland, Iceland and the Hebrides. Their return southwards is mainly on the other side of the Atlantic, and numbers have been seen off Land's End in November. Even if they flew direct, and were not constantly quartering the surface for food, this would be a tremendous circuit to make in the year. It calls also for a skill in navigation that we are far from understanding. How, after all this wandering, can they find their way back to the one small south Atlantic island on which they nest?

Compared with our detailed knowledge of the habits of land birds, we know extremely little of the oceanic ones. Wynne Edwards, who has studied them in the North Atlantic, says: "During the two-thirds of the year when they are not breeding our knowledge is fragmentary and has never been pieced together, not because it is uninteresting but because there are almost insurmountable difficulties to be overcome before completing the picture of the ebb and flow of bird life over so vast an area." There are some species which nest around our waters, such as Leach's Petrel. Nesting sites are known at scattered intervals from New England to Labrador, in Greenland, Iceland and on some of the islands west and north of Scotland. Even these, though, are usually very inaccessible spots, and to make things worse, the birds nest in burrows underground and enter or leave their burrows only after dark.

Others, such as various albatrosses are more accommodating about nesting in the open, and are even rather tame when approached, but they choose such out-of-the-way places as Gough Islands, Kerguelen, and Tristan de Cunha, Midway, Wake and Marcus. One, a shearwater, the Cahow, which until a few years ago was believed to have become extinct, is probably limited to one very small island in Bermuda.

Food Habits

Despite these handicaps, we are building up bit by bit a knowledge of these birds. Their nesting sites have been visited, their courtship studied and their development watched until they are old enough to leave land. We know something of their food from the debris round their nests, and stray birds which land on ships often help here by their habit of regurgitating their last meal.

A few observers have devoted time to counting them at sea. From their changes in seasonal distribution we are beginning to track down their migrations. It is here that a real contribution can be made by anyone who spends time at sea. I would like to cite as an example Chief Engineer Harold Backus. For many years he kept daily diaries of all birds seen on the various cruises of Woods Hole Oceanographic Institution's research vessel *Atlantis*. These provided a wonderful source of information on movements of ocean birds in the western north Atlantic and incidentally of migrating land birds too. The identification of birds on the wing calls for practice, but in most cases can be achieved with fair certainty. Alexander has published an invaluable hand book that covers the sea birds of all the oceans, and for the Southern Seas, there is the fine work of Murphy, *Oceanic Birds of South America*. The study is rewarding in itself and can help to pass long dull watches at sea. More than this, though, it will add to our knowledge of an important step in the food chain of the ocean.

For Further Reading:

Birds of the Ocean, by W. E. Alexander, 1928. G. P. Putnam Sons, New York. Pocket book size and covering the whole world. This includes not only the oceanic birds but also the coastal gulls, penguins and others.

Oceanic Birds of South America, by R. C. Murphy, 1930. Macmillan Co. (2 vols.) New York. A much more detailed and more local work. Too big to carry with you in the field, but an outstanding reference book.

A Field Guide to the Birds, by Roger Tory Peterson. Houghton Mifflin, 1947. This is a handbook for the identification of birds in North America east of the Rockies. It is particularly useful for spotting birds at a distance since it lists the patterns and distinctive marks rather than the anatomical differences and measurements. It is well illustrated and has useful sections, such as one on "Similar Species" which is especially helpful in field identification.

About The Authors

MASAO YOSHIDA

Masao Yoshida is a 39-year old Japanese with a degree in engineering from Tohoku University who joined the staff of the UNESCO Department of Natural Sciences in April 1955 to plan and direct UNESCO's marine sciences program. He is the son of Shigeru Yoshida, post-World War II Premier of Japan, and he traveled extensively during his youth as his father's diplomatic career took him to posts in China, Italy and Great Britain. Mr. Yoshida completed his university studies in January 1943, and entered the Japanese Navy immediately as a technical officer, assigned to a naval research laboratory in Tokyo. After the war, he returned to his university. He says, "Somehow I always had the notion that a college professor was the ideal job for me but my attempt at becoming a scholar ended in complete failure. After vainly struggling for three years, I decided to try my fortune somewhere else, and finally found a job with the occupation forces as an interpreter and liaison man between the section of the occupation headquarters concerned with science and technology and various Japanese government and industrial scientific organs and establishments." In 1950-51 Mr. Yoshida did graduate study in industrial engineering at The Johns Hopkins University, then returned to Japan, where he was a member of the Secretariat of the Science Council of Japan until he joined UNESCO last year.

FRANCIS MINOT

Mr. Minot for twenty years was a Naval architect and engineer in Boston, working on the design and construction of coastwise vessels, fishing vessels and special service craft. He specialized in the design and operation of fishing vessels. During this time he was consultant to the Atlantic Coast Fisheries Company and designed the motor trawlers *Kittiwake* and *Bittern* as well as making a worldwide survey of trawler design. He also designed the fishing vessels *Radio, Mystic, Falmouth, Pocomo, Yale, Lexington* and others for American and other owners. He was co-designer of the research vessel *Atlantis* of the Woods Hole Oceanographic Institution.

His training was at Haverford and Harvard Colleges and at the Massachusetts Institute of Technology. He is a member of the Society of Naval Architects and Marine Engineers and an associate of the Institute of Naval Architects of London. During World War II he was technical adviser to the U. S. Army Transport Corps at New York, in charge of seaworthiness and damage control of troop transports and merchant ships converted to military use.

Mr. Minot's experience and career well fit him to be the director of the Ocean Resources Institute at Woods Hole.

ROBERT F. SCAGEL

Dr. Robert F. Scagel has been assistant professor of oceanography in the Institute of Oceanography and assistant professor of phycology in the department of biology and botany at the University of British Columbia since 1952. He was born in Port Arthur, Ontario, Canada. After completing his early schooling in Ontario he went to British Columbia where he received his B.A. in 1947 and his M.A. in 1948 at the University of British Columbia. His Ph.D. was awarded at the University of California (Berkeley) in 1952.

While attending University he worked as a summer field assistant for the Fisheries Research Board of Canada at the Pacific Biological Station, Nanaimo, and the Provincial Fisheries Department of British Columbia. In addition to his teaching and research activities at the University of British Columbia he has given instruction as a visiting professor in phycology in the summer quarter at the Friday Harbor Laboratories of the University of Washington for the past three years.

His chief research interests have been in biological oceanography, including plankton studies and the ecology of bottom-living organisms, and in the taxonomy and morphology of the marine algae.

ALFRED V. VOLPE

Mr. Volpe was born on May 24, 1919, in New Haven, Connecticut. He is married, with a daughter aged 7½. He received the B.S. degree from the University of Miami and has completed graduate courses for the master's degree in fishery science.

He served as aerial photographer with the 29th Bomb Group in World War II. Since then he has worked as photographer, building trade paper reporter and building contractor, prior to entering college.

A love of sailing and the sea turned his interests to marine science. His experience in marine research includes research on the life histories of tarpon and snook and assistance in setting up a large scale statistical survey of angling activities in Florida.

SCIENTISTS AND AUTHORS

In order that the Bulletin may fully reflect the international nature of its membership and of its objectives, the Editor will be glad to consider for publication illustrated articles for the general reader dealing with institutions of marine science or with subjects related to marine research throughout the world.

Looking Ahead

THE BULLETIN is mailed without obligation to those who are interested in the oceans and in the progress of scientific research concerning it.

It is hoped that, with the growing interest and advice of members and others who receive the Bulletin, it will be possible in the future greatly to expand and develop it and eventually to include articles in nontechnical language from all parts of the world, fully illustrated in color. In order to do this, the editors welcome advice and criticism, as well as articles suitable for publication.

Since the Foundation is a nonprofit organization it is necessary to support the cost of publication by extending the active membership. It is hoped that those who are interested in the objectives of the Foundation and who enjoy the Bulletin will give their support to this by bringing it to the attention of their friends and by becoming members themselves.

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